National Marine Fisheries Service Endangered Species Act (ESA) Section 7 Consultation and Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation

Action Agencies: National Marine Fisheries Service (NMFS)

Species Affected: Upper Columbia River (UCR) Spring-run Chinook salmon (Oncorhynchus *tshawytscha*) and UCR steelhead (0. *mykiss*)

Essential Fish Habitat (EFH) Affected: Pacific salmon

Activities Considered: NMFS issuance of ESA permit 1592 jointly to Grant PUD, WDFW, and YN

Consultation Conducted by: The Salmon Recovery Division (SRD), Northwest Region (NWR), NMFS Consultation Number F/NWR/2006/06000.

This Biological Opinion (Opinion) constitutes NMFS' review of one ESA section 10(a)(1)(A) permit action that could affect UCR spring Chinook salmon and steelhead. It has been prepared in accordance with section 7 of the ESA of 1973, as amended (16 U.S.C. 1531 et seq.). It is based on information provided in the application, published and unpublished scientific information on the biology and ecology of listed salmonids in the action areas, and other sources of information. A complete docket of this consultation is on file with the SRD in Portland, Oregon.

NMFS concludes that issuing the proposed ESA section 10(a)(1)(A) permit for the activities discussed in this Opinion is not likely to jeopardize the continued existence of endangered UCR spring Chinook, or threatened UCR steelhead. Further, the activities are not likely to adversely modify any designated critical habitat or EFH.

Approved by: D. Robert Lohn
D. Robert Lohn, Regional Administrator

Date: 4/13/07
(**Expires May 31, 20**10)

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EXECUTIVE SUMMARY

The NMFS has completed its analysis of the impacts associated with implementing the Upper Columbia River (UCR) Spring Chinook Salmon White River Supplementation Program, concluding consultation under section 7 of the Endangered Species Act (ESA). The Public Utility District No. 2 of Grant County (Grant PUD), the Washington Department of Fish and Wildlife (WDFW), and the Confederated Tribes and Bands of the Yakama Nation (YN) working cooperatively with the U.S. Fish and Wildlife Service (USFWS), the Confederated Tribes of the Colville Reservation, and NMFS are the primary operating entities of the program.

Under the ESA, “conserve,” means to use all methods and procedures including research, census, law enforcement, habitat acquisition and maintenance, propagation, live trapping, and transplantation” Section 3(3). Section 10(a)(1)(A) of the ESA anticipates that need to permit “any act otherwise prohibited by section 9 for scientific purposes or to enhance the propagation or survival of the affected species.”

White River spring Chinook are important to the conservation of the UCR spring Chinook salmon Evolutionarily Significant Unit (ESU). The action analyzed in this Biological Opinion is an initiative to enhance the survival of the ESU and reduce the short-term risk of extinction by conservation the genetic resources found in the White River spring Chinook spawning aggregate.

This consultation is based on the best available information and has incorporated data from a number of ongoing processes. These processes include implementation of the Priest Rapids Project Salmon and Steelhead Settlement Agreement, ESA recovery planning including work by the Interior Columbia Technical Recovery Team (ICTRT), and the re-licensing of the Priest Rapids Project under the Federal Energy Regulatory Commission (FERC).

Analysis of this program was done by evaluating the benefits and risks to natural-origin populations from artificial propagation programs identified by the National Research Council (NRC 1996). Based on the analysis, NMFS concluded that the proposed artificial propagation program would benefit UCR spring Chinook salmon and would not jeopardize UCR steelhead or UCR spring Chinook salmon or result in the destruction or adverse modification of their critical habitat. This conclusion is based on the following factors:

- No permanent hatchery facilities would be constructed in the White River basin;
- The primary constituent elements necessary for listed species within the action area would not be adversely affected
- Hatchery facilities outside the basin that may be used for the program are already in existence and in operation for other artificial propagation programs have undergone separate ESA consultations;
- Broodstock collection activities would result in the taking of an estimated equivalent to 1 adult spring Chinook salmon and no impacts on listed steelhead
- Disease protocols at the facilities are in place to minimize disease occurrences at the hatchery facilities;

- Ecological interactions between natural origin listed species and hatchery produced juveniles would be limited through release strategies (e.g., release size, release location, release timing, volitional release); and
- The program is designed to provide a numeric boost in the abundance of listed spring Chinook salmon spawning in the White River while maintaining genetic stock integrity of the population;
- The short duration of the proposed permit;
- Monitoring of program would be conducted to determine if the program is meeting stated objectives;
- Regular reports would be submitted to NMFS covering all aspects of the program; and
- Terms and conditions in the permit require adherence to identified best management practices for all aspects of the program, including monitoring and reporting.

A key component of the proposed action involves monitoring and evaluation, and mechanisms for adapting the propagation program based on new information. Where potentially adverse interactions with listed species may occur, the permit applicants have proposed monitoring and evaluation activities to determine the level of these interactions, and to implement practices that would adequately minimize adverse effects. NMFS will assess this information on an annual basis and determine whether reinitiation of consultation is warranted.

The Incidental Take Statement issued for this program includes reasonable and prudent measures that minimize and reduce the anticipated level of take of listed steelhead associated with the proposed artificial propagation programs.

A process to determine a long-term approach to implementing the UCR spring Chinook salmon White River supplementation program is under development. The fish resource co-managers and Grant PUD are working with the public using public meetings, newsletters, internet web sites, and workshops held near the White River basin. Any long-term plan for implementing a supplementation program would be subject to a separate consultation process under the ESA.

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1 INTRODUCTION

This Biological Opinion (Opinion) is the result of a consultation carried out pursuant to section 7(a)(2) of the ESA and implementing regulations 50 CFR §402 concerning one artificial propagation program that rears and releases ESA-listed UCR spring Chinook salmon into the White River in Chelan County in the state of Washington. This Opinion considers the effects of facility operations, juvenile release, broodstock collections, and related monitoring and evaluations on ESA-listed species of anadromous salmon and steelhead in the action area. NMFS is consulting with itself on its proposed issuance of a direct take permit (1592) pursuant to section 10(a)(1)(A) of the ESA for one artificial propagation program (e.g., hatchery program) implemented jointly by the Public Utility District No. 2 of Grant County (Grant PUD), the Washington Department of Fish and Wildlife (WDFW), and the Confederated Tribes and Bands of the Yakama Nation (YN) in cooperation with the U.S. Fish and Wildlife Service and the Confederated Tribes of the Colville Reservation.

1.1 Consultation History

On December 9, 1998, NMFS received an application for an ESA section 10 permit from the WDFW requesting authorization for the directed take of UCR spring Chinook salmon associated with supplementation[1] recovery programs it operates in the UCR basin. This permit application included the operation of the White River Spring Chinook Salmon Program; however, funding for the White River program had not been assured by WDFW or any other party at that time. Under ESA section 10(a)(2)(B)(iii) NMFS must have assurance from the permit applicant that adequate funding for the plan will be provided prior to issuing an ESA section 10 permit. Because funding of the White River Spring Chinook Salmon Program was not certain, NMFS was unable to authorize the activities related to White River Spring Chinook Program in Permit 1196. Permit 1196 authorizing other proposed activities was issued to the WDFW on August 16, 2002 (67 FR 58021) and amended on January 20, 2004. Additional information regarding permit 1196 is available at NMFS web site (*www.nwr.noaa.gov).*

Initially in 1997, and supplemented in 1998, Grant PUD filed a request with the Federal Energy Regulatory Commission (FERC) to amend its license for the Priest Rapids Project No. 2114 in order to implement an Interim Protection Plan for UCR steelhead and UCR spring Chinook salmon affected by operation of the Priest Rapids Project (includes Priest Rapids and Wanapum Dams). Section 7 of the ESA requires the FERC to ensure, in consultation with NMFS, that the action of amending Grant PUD's operating license as proposed is not likely to jeopardize the continued existence of any listed species, or destroy or adversely modify any designated critical habitat for those species. As such, on January 20, 1999, FERC requested a consultation under the ESA with NMFS on Grant PUD's proposed Interim Protection Plan.

During the course of evaluating the action proposed by Grant PUD on behalf of FERC, NMFS determined that the action, as proposed, was likely to jeopardize the continued existence of UCR spring Chinook salmon and UCR steelhead. NMFS, in consultation with Grant PUD, the

[1] Supplementation is defined as the use of artificial propagation in the attempt to maintain or increase natural production while maintaining the long term fitness of the target population, and keeping the ecological and genetic impacts on non-target populations within specified biological limits (RASP 1992).

WDFW, the YN, the CCT, and the USFWS, developed a Reasonable and Prudent Alternative (RPA) to the proposed action which, if implemented with the proposed action would not jeopardize the continued existence of UCR spring Chinook salmon and UCR steelhead. Included in the RPA was the funding and support of the White River Spring Chinook Salmon Program (NMFS 2004a).

The regulations implementing Section 7 of the ESA (50 CFR §402.2) define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that 1) can be implemented in a manner consistent with the intended purpose of the action, 2) can be implemented consistent with the scope of the action agency's legal authority, 3) are economically and technically feasible, and 4) would not jeopardize the continued existence of the listed species.

Subsequent to NMFS issuance of the Biological Opinion on the Interim Protection Plan for Operation of the Priest Rapids Hydroelectric Project FERC Project No. 2114, the FERC issued an order amending Grant PUD's license that included implementation of the Interim Protection Plan and other related actions on December 16, 2004 (FERC 2004). Additional information specific to the FERC order is available on Grant PUD's web site at *www.gcpud.org*.

Based on the issuance of the Biological Opinion that included the RPA and the issuance of an amended operational license by the FERC, Grant PUD has submitted to NMFS an application for an ESA section 10(a)(1)(A) permit to immediately implement the White River Spring Chinook Salmon Program pursuant to the RPA in the Biological Opinion on the operation of the Priest Rapids Project. The permit application was received on August 27, 2006 and requests authorization under the ESA for a period of three years in order to carry out activities necessary for the immediate implementation and support of the White River spawning aggregate of the Wenatchee Spring Chinook population. The permit application requests issuance of a permit to be held jointly by Grant PUD, the WDFW, and the YN. Following NMFS initial review, the application was determined to be complete and consultation number 2006/06000 and permit number 1592 were assigned to this action. We then prepared a draft Environmental Assessment (EA) consistent with the National Environmental Policy Act (NEPA) which, along with the permit application was published in a *Federal Register* notice asking for public comment on both documents (71 FR 69551). The public was given 30 days to comment on the application and draft EA; once that period closed, the consultation proper was begun.

1.2 Analysis Framework

Over the course of the last decade and hundreds of ESA section 7 consultations, NMFS developed the following four-step approach for applying the ESA Section 7(a)(2) standards when determining what effect a proposed action is likely to have on a given listed species and its critical habitat. What follows here is a summary of that approach.

1. Describe the proposed action (section 2).

2. Define the biological requirements and current status of each listed species and the relevance of the environmental baseline to the species current status in the action area (section 3).

3. Determine the effects of the proposed action on listed species and their habitat (section 4.1 and 4.2) and evaluate any cumulative effects within the action area (section 4.3).

4. Determine whether the species can be expected to survive with an adequate potential for recovery under (a) the effects of the proposed (or continuing) action, (b) the effects of the environmental baseline, and (c) any cumulative effects—including all measures being taken to improve salmonid survival and recovery (section 4.3).

The fourth step above requires a two-part analysis. The first part focuses on the action area and defines the proposed action's effects in terms of the species' biological requirements in that area (i.e., impacts on primary constituent elements). The second part focuses on the species itself. It describes the action's impact on individual fish—or populations, or both—and places those impacts in the context of the Distinct Population Segment (DPS) or ESU[2] as a whole. Ultimately, the analysis seeks to answer the questions of whether the proposed action is likely to jeopardize a listed species' continued existence or destroy or adversely modify its designated critical habitat (where relevant).

2 PROPOSED ACTION

NMFS proposes to issue ESA section 10(a)(1)(A) permit 1592 jointly to Grant PUD, the WDFW, and the YN. The permit would authorize take of endangered naturally produced and artificially propagated UCR spring Chinook salmon, and threatened UCR steelhead that would occur as a result of implementing an artificial propagation (hatchery) program to enhance the White River spawning aggregate of the UCR spring Chinook salmon population. "Take" is defined in section 3 of the ESA; it means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect [a listed species] or to attempt to engage in any such conduct.

The artificial propagation action proposed by Grant PUD, the WDFW and YN is to maintain and operate a supplementation program to enhance the propagation of the spawning aggregated from the Wenatchee spring Chinook salmon population which is part of the endangered UCR spring Chinook salmon ESU to provide options for recovery of the listed ESU. The program includes rearing fish from fertilized eggs or fry through maturity in captivity, spawning the mature fish, and rearing their progeny for release into natural habitat (i.e., supplementation).

Coordination of program and validation of the scientific basis of proposed actions takes place through the Priest Rapids Coordinating Committee Hatchery Subcommittee (PRCC HSC), a team of biologists and scientists representing the various agencies and tribes associated with the project. The funding agency (Grant PUD) and the permitting authority (NMFS, Salmon Recovery Division, Hatcheries and Inland Fisheries Branch) are also represented on the PRCC HSC. The PRCC HSC has adopted protocols regarding review of aquaculture proposals and

[2] An ESU species of Pacific salmon (Waples 1991) and a DPS of steelhead (71 FR 834) are considered to be "species" as the word is defined in section 3 of the ESA. In addition, it should be noted that the terms "artificially propagated" and "hatchery" are used interchangeably in the Opinion, as are the terms "naturally propagated" and "natural."

decision making processes. In addition, other agency personnel with expertise in fish behavior, genetics, fish health, and fish culture serve as advisors for specialized decisions. Monthly meetings, which are open to the public and other agencies, are held to review status of projects and proposals for actions. This body reviews program activities, coordinates research on specific issues, and makes recommendations for future activities. Specific fish culture protocols (e.g., fish rearing density, rearing container size, water temperature, diet), specific fish transportation protocols (e.g., temperature tempering, transport density, tank configuration, safety contingency plans), and the annual operations of the project (spawning protocols, priorities for distribution of fish, management decisions) are reviewed and approved by the PRCC HSC.

The project includes monitoring and evaluation (M&E) of survival of fish produced by the propagation program and the impacts of the project on natural production. The proposed actions are designed to affect only UCR spring Chinook salmon. However, listed UCR steelhead may be present in some of the waters that are affected by the permitted activities.

This opinion evaluates the biological impacts of the proposed action on listed species of anadromous salmonids in the Columbia River basin and in particular within the White River basin in Chelan County, Washington. This opinion addresses the proposed issuance of the section 10 permit 1592 jointly to Grant PUD, the WDFW, and the YN. The analysis in this opinion will determine whether the NMFS action of authorizing the direct take of listed UCR spring Chinook salmon for the supplementation program is likely to jeopardize the continued existence of the UCR Spring Chinook Salmon ESU or the UCR Steelhead DPS or result in the destruction or adverse modification of their critical habitat.

As part of permit 1592 we include terms and conditions that are intended to minimize impacts on listed species, and ensure that we receive information about the effects the permitted activities have on the species concerned. The terms and conditions are listed after the fisheries description section below. We further propose that permit 1592 should expire three years from the date of signature by NMFS.

2.1 Specific Activities

The permit application requests authorization under the ESA for a period of three years in order to carry out activities necessary for the immediate implementation and support of the White River spawning aggregate of the Wenatchee spring Chinook population in a manner that is consistent with the Interior Columbia Technical Recovery Team's (TRT) recommendations to achieve a highly viable population of spring Chinook salmon in the Wenatchee basin (ICTRT 2007).

The enhancement activities are:

1. Collect up to 1,500 eggs or fry of White River stock annually.

2. Rear collected eggs and fry (i.e., first or F1 generation) in a hatchery facility to adult stage.

3. Artificially spawn the mature adult broodstock at a hatchery facility following a mating protocol designed to protect the genetic diversity of the cultured population.

4. Rear resultant progeny (i.e., second or F2 generation) to achieve the target release number of 150,000 yearling smolts using best fish culture practices and approved therapeutants while holding, transferring, and rearing the listed salmon in captivity.

5. Provide rearing for fish in excess of 150,000 yearling smolt target to achieve a sufficient size for marking, then release fish into vacant habitat in the White River basin.

6. Acclimate F2 generation to the White River using temporary facilities or strategies that allow the smolts to imprint on the White River to encourage fidelity of adults.

7. Release up to 150,000 yearling smolts into the White River at a time and location that maximizes likelihood of survival and return to the White River.

8. Prior to release mark smolts with internal and/or external tags or marks as necessary to track migration and evaluate survival.

9. Monitor juveniles released from the program and the naturally produced fish in the White River.

10. Monitor the adult returns for spawning success and survival and migration of the progeny of both the hatchery-reared and natural-origin salmon, using methods and equipment as necessary to collect and observe fish.

11. Collect biological samples from adult and juvenile spring Chinook salmon as necessary for monitoring and evaluation of program effects.

12. Coordinate all decisions and comply with recommendations produced by the PRCC HSC previously described.

Additional detail on each activity is provided in the permit application (Grant PUD 2006). A long-term plan in the form of a Hatchery and Genetics Management Plan (HGMP) for the program is under development by Grant PUD, the WDFW, the YN and other Federal and Tribal resource managers. When the HGMP is completed it will be evaluated under the ESA and NEPA as required by law.

2.2 Action Area

An action area is defined as the geographic extent of all direct and indirect effects of a proposed agency action [50 CFR §402.02 and §402.14(h)(2)]. The action area for the proposed propagation program includes:

- The White River Basin: The White River and Lake Wenatchee in Chelan County, Washington that serve as the spawning and juvenile rearing areas for the White River spawning aggregate segment of the Wenatchee spring Chinook salmon population.

- Off-site Rearing Locations: Most of the artificial propagation actions take place at offsite locations including Little White Salmon National Fish Hatchery operated by the USFWS in the lower Columbia River, Eastbank Hatchery operated by WDFW on the UCR, and a privately owned hatchery facility in Rochester near Olympia, Washington. The operation of state or federally operated hatchery facilities outside the White River basin was considered in separate ESA consultations (NMFS 2002a, b, 2003a). No collection or release of fish from the proposed program would occur at those locations.

The Wenatchee and Columbia Rivers serve as a migration corridor between the White River and the Pacific Ocean. Interactions between fish released from the proposed artificial propagation program and other ESA-listed anadromous species in the Columbia River corridor downstream of the action area in the White River and Lake Wenatchee were considered by NMFS. Determining the nature of these transient interactions that occur during migration are difficult due to the biological attributes of salmon and steelhead, the dimensions and variability in the Columbia River system, and the cycles in the ocean environment. Based on the large scale of the Columbia River, the level of proposed artificial propagation relative to the artificial propagation programs in the Columbia River basin, and the limited period of interaction during active migration, NMFS has determined that impacts on anadromous fish in this corridor are not discernable in the Columbia River basin. Therefore, by regulatory definition, the migration corridors were not part of the action area. For example, in the Columbia River basin, artificially propagated spring Chinook salmon associated with the proposed program would comprise only about 0.6 percent of total artificially propagated spring Chinook salmon released annually (23.8 million yearling spring Chinook salmon were released into the Columbia River basin in 2006 *www.cbr.washington.edu/cgi-bin/dart*). Habitat for Chinook salmon in this migration corridor has been lost or degraded by more than 50 percent and the total number of spring Chinook salmon using this corridor is less than historical migration estimates. In addition, several hatchery reform measures have been implemented to limit interactions between natural and hatchery salmonids while in the migration corridor (NMFS 1999a).

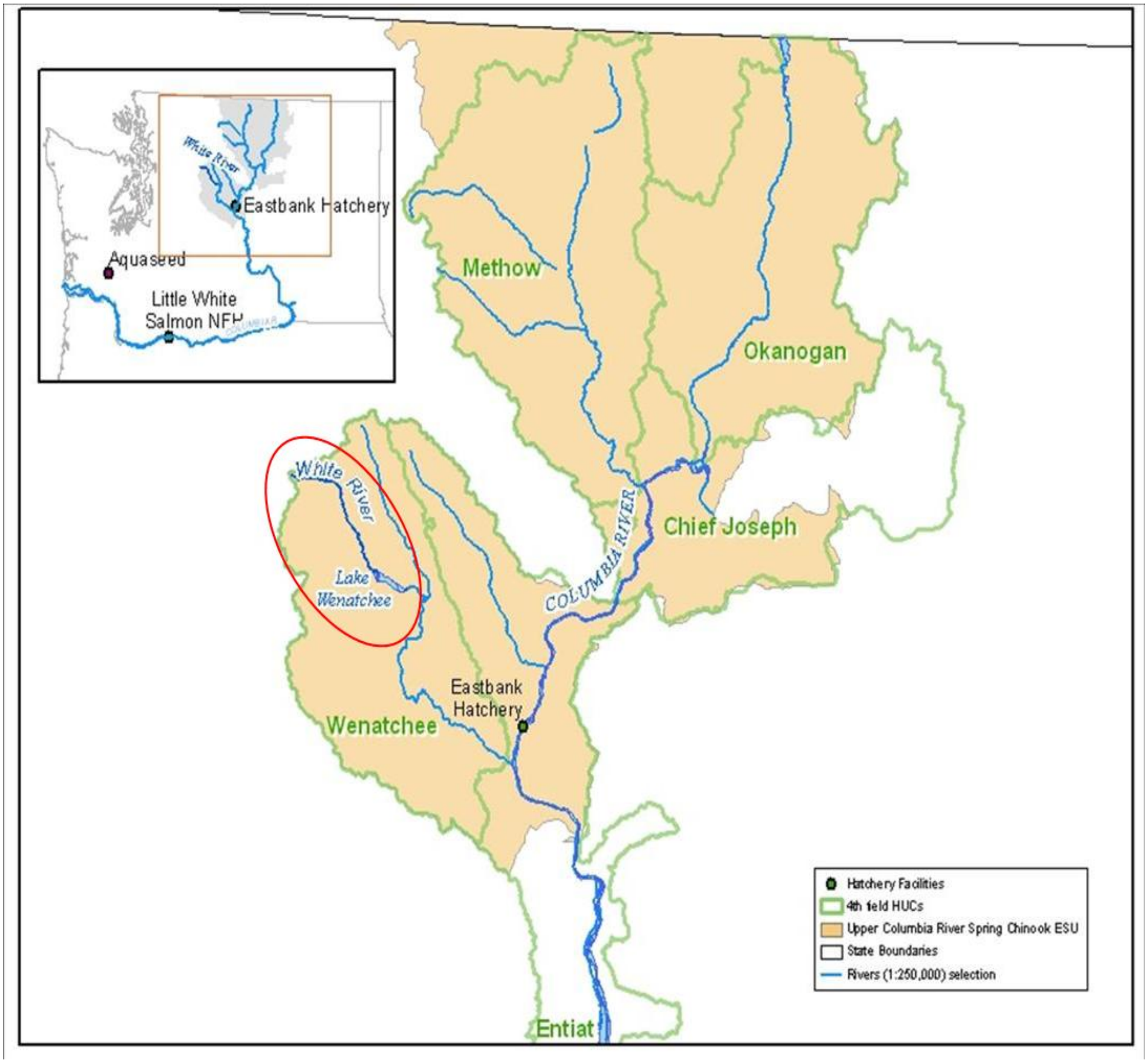

Figure 1. Map of Upper Columbia River basin with the action area for proposed ESA Permit 1592 identified in the circle and location of existing hatchery facilities in Washington State that would be used to carry out the Upper Columbia River Spring Chinook Salmon White River Supplementation Program.

2.3 Terms and Conditions

NMFS proposes to issue permit 1592 (Attachment A) with terms and conditions as stipulated by section 10 of the ESA. The conditions are designed to minimize ESA-listed fish mortalities and adverse impacts during; the collection of eggs or fry from naturally deposited redds, rearing of juveniles in a hatchery environment, release of smolts into the White River to enhance the naturally spawning population, the monitoring of juvenile fish produced in the White River, and the monitoring of adult salmon returns to the White River. Terms and conditions in the permit can be segregated based on life stage and location of potential effect related to; the collections of eggs or fry to rear in captivity for broodstock (aka, First generation or F1 generation), rearing and release of the progeny of the broodstock (aka, second generation or F2 generation), general conditions that apply to both the F1 and F2 generations, and monitoring activities that would occur in the natural environment. Additionally, terms and conditions requiring reports and notification of specific activities or situations would be included followed by general conditions that would ensure adequately trained individuals are carrying out the activities and the optimal conditions for ESA-listed fish are maintained during all authorized activities.

Of primary concern in the development of conditions for the proposed permit is the necessity to take special measures to avoid adverse impacts from artificial propagation and to preserve the genetic and life history characteristics of the listed species. The direct take and incidental take of listed anadromous salmonids is subject to the provisions of the Permit Holder's application and the conditions specified in this permit.

3 RANGE-WIDE STATUS OF THE SPECIES

To determine a species’ status under extant conditions (the environmental baseline), it is necessary to ascertain the degree to which the species’ biological requirements are being met at that time and in that action area. For the purposes of this consultation, the salmon and steelhead biological requirements for the ESUs and DPSs in the action area are expressed in two ways: The viable salmonid population (VSP) parameters such as natural-origin fish numbers, natural-origin fish distribution, and natural-origin fish trends throughout the action area; and the condition of various essential habitat features such as water quality, stream substrates, and food availability. These two types of information are interrelated, given that the condition of a given habitat has a large impact on the number of fish it can support. Nonetheless, it is useful to separate the species’ biological requirements into these parameters because doing so provides a more complete picture of all the factors affecting listed salmon and steelhead survival.

In order to describe a species’ status, it is first necessary to define precisely what “species” means in this context. Traditionally, one thinks of the ESA listing process as pertaining to entire taxonomic species of animals or plants. While this is generally true, the ESA also recognizes that there are times when the listing unit must necessarily be a subset of the species as a whole. In these instances, the ESA allows a DPS of a species to be listed as threatened or endangered. The listed fish units considered in this Opinion are just such DPSs and, as such, are for all intents and purposes considered “species” under the ESA.

NMFS adopted an approach for defining salmonid DPSs in 1991 (56 FR 58612). It states that a population or group of populations is considered distinct if they are “substantially reproductively isolated from conspecific populations,” and if they are considered “an important component of the evolutionary legacy of the species.” Such a distinct population or group of salmon is often referred to as an ESU of the species. Hence, UCR Chinook constitute an ESU of the species *O. tshawytscha*, while UCR steelhead is simply termed a DPS. As stated in Footnote 2, these terms are both equivalent to “species” as section 3 of the ESA defines the word.

On March 24, 1999, NMFS first listed UCR spring Chinook salmon as an endangered species under the ESA (64 FR 14308). In that listing determination, NMFS concluded that the UCR spring Chinook salmon were in danger of extinction throughout all or a significant portion of their range. NMFS also determined that six hatchery stocks in the UCR basin (Chiwawa, Methow, Twisp, Chewuch, and White Rivers and Nason Creek) should be included as part of the species because they were considered essential for recovering the fish. When NMFS re-examined the status of the UCR Chinook in 2005 (70 FR 37160), we came to the same conclusion that the species warranted listing as endangered.

On August 18, 1997, NMFS first listed UCR steelhead as an endangered species under the ESA (62 FR 43937). In that determination, NMFS concluded that the UCR steelhead were in danger of extinction throughout all or a significant portion of their range. NMFS also determined that one hatchery stock in the upper Columbia River basin, the Wells Hatchery stock, should be considered part of the species because it was essential for the recovery of the species at the time 62 FR 43937). When NMFS re-examined the status of the UCR steelhead, we determined that their status had improved to the point where they could be listed as threatened rather than endangered (71 FR 834). The most recent listing included fish from the following hatchery programs: Wenatchee River, Wells Hatchery in the Okanogan and Methow Rivers, Winthrop National Fish Hatchery (NFH), Omak Creek, and Ringold hatchery.

These fish were listed because NMFS determined (twice) that a number of factors—both environmental and demographic—had caused them to decline to the point where they were likely within the foreseeable future to become endangered or, in the case of UCR Chinook, extinct. These factors for decline affect the species' biological requirements at every life stage and they arise from a number of different sources. This section of the Opinion explores those effects and defines the context within which they take place.

The best scientific information presently available suggests that a multitude of factors, past and present, have contributed to the decline of West Coast salmonids. NMFS reviewed much of that information in its recent consultation on operation of the Federal Columbia River Power System (FCRPS) (NMFS 2004b), and that review is summarized here. NMFS recognizes that natural environmental fluctuations have likely played a role in the species' recent declines. However, NMFS believes that human-induced impacts have reduced the species ability to survive environmental fluctuations and rebound to viable status. In analyzing the actions addressed by this permit, NMFS recognizes that these out-of-sub-basin effects are the factors that caused the decline of this population to the point that it has been listed as endangered and, similarly, are key factors that have prevented recovery of this population. The White River propagation program is not designed to address the out-of-sub-basin effects that make up much of the "Environmental Baseline" for this listed ESU. The program is designed to prevent the extinction of one spawning aggregate in the Wenatchee spring Chinook population to preserve the options for restoration of naturally spawning populations when the detrimental conditions outside the White River basin are addressed. Actions designed to correct migration corridor conditions are outside the scope of this opinion. Therefore, this analysis focuses on the effects of the supplementation program, not the other factors such as the FCRPS that are responsible for the decline of the species.

The biological requirements during the species' life history stages can be obtained by identifying the essential features of their critical habitat (see section 3.5 below). These have been fully discussed in recent biological opinions (NMFS 2000a; NMFS 2004b) and what follows is a brief summary of the factors that affect these requirements in the action areas.

3.1.1 Hydropower System Effects

Anadromous salmonids in the Columbia River basin have been dramatically affected by the development and operation of the hydroelectric projects on the Columbia River. Storage dams have eliminated spawning and rearing habitat and have altered the natural hydrograph, decreasing spring and summer flows and increasing fall and winter flows. Power operations cause flow levels and river elevations to fluctuate, affecting fish movement through reservoirs and riparian ecology, and stranding fish in shallow areas. The dams in the migration corridor alter smolt and adult migrations. Smolts experience a high level of mortality passing the dams. The dams also have converted the once-swift river into a series of slow-moving reservoirs, slowing the smolts' journey to the ocean and creating habitat for predators. Water velocities throughout the migration corridor now depend far more on volume runoff than before the development of the mainstem reservoirs.

There have been numerous changes in the operation and configuration of the hydroelectric projects as a result of ESA consultations between NMFS and the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (Corps), the Bureau of Reclamation (BOR), Chelan Public Utility District (PUD), Douglas PUD and Grant PUD . The changes have improved survival for the ESA-listed fish migrating through the Columbia River (NMFS 2004b).

3.1.2 Habitat Effects

The quality and quantity of freshwater habitat in much of the Columbia River basin have declined dramatically in the last 150 years. Forestry, agriculture, road construction, hydro system development, mining, and urbanization have radically changed the quality and reduced the quantity of historical habitat conditions of the basin. Nearly 90 percent of the habitat originally available to anadromous salmonids in the Columbia Basin has been lost or degraded (Brannon et al. 2002). With the exception of fall Chinook salmon, which generally spawn and rear in the mainstem rivers, salmon and steelhead spawning and rearing habitat is found in the tributaries to the Snake and Columbia Rivers. Anadromous fish typically spend from a few months to three years rearing in freshwater tributaries. Depending on the species, they spend from a few days to an extended period of time in the Columbia River estuary before migrating out to the ocean. They spend another one to four years in the ocean before returning as adults to spawn in their natal streams.

The Basinwide Recovery Strategy (NMFS 2000b) outlines a broad range of current programs designed to improve habitat conditions for anadromous fish. Because most of the basin's anadromous fish spawning habitat is in Federal ownership, Federal land management programs are of primary importance. Examples of Federal actions likely to affect salmonids in the ESA-listed ESUs and steelhead DPSs include authorized land management activities of the U.S. Forest Service (USFS) and Bureau of Land Management (BLM). Federal actions, including the Corps' section 404 permitting activities under the Clean Water Act, the Corps' permitting activities under the River and Harbors Act, National Pollution Discharge Elimination System permits issued by Environmental Protection Agency (EPA), highway projects authorized by the Federal Highway Administration, FERC licenses for non-Federal development and operation of hydropower, and Federal hatcheries may result in impacts to ESA-listed anadromous fish.

Several recovery efforts underway are expected to slow or reverse the decline of salmon and steelhead populations. Notable efforts within the range of the UCR salmon and steelhead ESU/DPSs are the Northwest Forest Plan, PACFISH, and the Draft Upper Columbia Salmon and Steelhead Recovery Plan (UCSRB 2006). PACFISH is an ecosystem-based aquatic habitat and riparian-area management strategy that covers the majority of the basin accessible to anadromous fish and includes specific prescriptions designed to halt habitat degradation. PACFISH provides objectives, standards, and guidelines that are applied to all Federal land management activities such as timber harvest, road construction, mining, grazing, and recreation. USFS and BLM implemented PACFISH beginning in 1995. Several other efforts are also being carried forward by NMFS, USFS, and BLM. These components include implementation of monitoring, a system of watersheds that are prioritized for protection and restoration, improved and monitored grazing systems, road system evaluation and planning requirements, mapping and analysis of unroaded areas, multi-year restoration strategies, and batching and analyzing projects at the watershed scale.

The most substantive element of the Northwest Forest Plan for anadromous fish is its Aquatic Conservation Strategy, a regional-scale aquatic ecosystem conservation strategy that includes: (1) Special land allocations (such as key watersheds, riparian reserves, and late-successional reserves) to provide aquatic habitat refugia; (2) special requirements for project planning and design in the form of standards and guidelines; and (3) new watershed analysis, watershed restoration, and monitoring processes. These components collectively are designed so that Federal land management actions will achieve Aquatic Conservation Strategy objectives that strive to maintain and restore ecosystem health at watershed and landscape scales to protect habitat for fish and other riparian-dependent species and resources and to restore currently degraded habitats.

The Basin-wide Recovery Strategy also outlines a large number of non-Federal habitat programs. Because non-Federal habitat is managed predominantly for private rather than public purposes, expectations for non-Federal habitat are harder to assess. Degradation of habitat for ESA-listed fish from activities on non-Federal lands is likely to continue to some degree, although at a reduced rate due to state, tribal, and local recovery plans. Because a substantial portion of land in the ESA-listed ESUs and steelhead DPSs is in state or private ownership, conservation measures on these lands will be important to protecting and recovering ESA-listed salmon and steelhead populations. NMFS recognizes that strong conservation benefits will accrue from specific components of many non-Federal conservation efforts; however, some of those conservation efforts are very recent and few address salmon conservation at a scale that is adequate to protect and conserve entire ESUs and steelhead DPSs. NMFS will continue to encourage non-Federal landowners to assess the impacts of their actions on ESA-listed salmonids. In particular, NMFS will encourage state and local governments to use their existing authorities and programs to protect habitat, and will encourage the formation of watershed partnerships to promote conservation in accordance with ecosystem principles.

3.1.3 Hatchery Effects

For more than 100 years, hatcheries in the Pacific Northwest have been used to replace natural production lost as a result of the construction of hydropower dams and other development, and to enhance fisheries, not to protect and rebuild naturally-produced salmonid populations. As a result, most salmonid populations in the region are primarily hatchery fish. In 1987, for example, 95 percent of the Coho salmon, 70 percent of the spring Chinook salmon, 80 percent of the summer Chinook salmon, 50 percent of the fall Chinook salmon, and 70 percent of the steelhead returning to the Columbia River basin originated in hatcheries (CBFWA 1990). While hatcheries certainly have contributed greatly to the overall numbers of salmonids, only recently has the effect of hatcheries on native wild populations been demonstrated. In many cases, these effects have been substantial. For example, the production of hatchery fish, among other factors, has contributed to the 90 percent reduction in wild Coho salmon runs in the lower Columbia River over the past 30 years (Flagg et al. 1995).

NMFS has identified four categories of risk that hatcheries can pose on wild salmon and steelhead: (1) ecological effects, (2) genetic effects, (3) over-harvest effects, and (4) masking effects (NMFS 2000c). Ecologically, hatchery fish can increase predation on, displace, and/or compete with wild fish. These effects are likely to occur when fish are released in poor condition and do not migrate to marine waters, but rather remain in the streams for extended rearing periods during which they may prey on or compete with wild fish. Hatchery fish also may transmit diseases, and hatcheries themselves may release diseases into streams via water effluents. Genetically, hatchery fish can affect the genetic variability of native fish via interbreeding, either intentionally or accidentally. Interbreeding can also result from the introduction of stocks from other areas. Theoretically, interbred fish are less adapted to, and less productive within, the unique local habitats where the original native stock evolved.

A number of hatchery reforms and improvements have been implemented or partially implemented in the last 20 years. Some of these reforms include mass marking (beginning in the mid-1980s with steelhead), regional fish health protocols, limiting transfers of fish between basins, reduced rearing densities, managing adults on the spawning grounds, etc.

NMFS has determined that there is a need for additional hatchery reform and conservation actions (NMFS 2000d). Federal agencies are working with the Northwest Power and Conservation Council (NWPCC) to accelerate funding and implementation of the reform measures from the hatchery biological opinions and related actions that should proceed over the next 1 to 3 years. Such reforms will be pursued in the context of the Hatchery and Genetic Management Plans (HGMP). The HGMP is a tool for defining goals and objectives of a particular hatchery and its relationship to prioritized basin objectives, including harvest opportunities and wild stock performance. Specifically, each HGMP should ensure that genetic broodstock selected is appropriate, that it minimizes the potential for adverse ecological effects on wild populations, that program operations are driven by explicit program goals, and that it is integrated into basin-wide strategies to meet broader objectives. Future management of hatcheries will also need to occur within the context of fully implemented adaptive-management programs that focus on watershed management, not just on the fish themselves (NRC 1996).

3.1.4 Harvest Effects

Initially, the non-Indian fisheries targeted spring and summer Chinook salmon, and these runs dominated the commercial harvest during the 1800s. Eventually, the combined ocean and freshwater harvest rates for Columbia River spring and summer Chinook salmon exceeded 80 percent and sometimes 90 percent of the run, contributing to the species' decline (Ricker 1959). From 1938 to 1955, the average harvest rate dropped to about 60 percent of the total run. In the 1950s and 1960s, harvest rates further declined to about 20 percent (Raymond 1988).

The construction of The Dalles Dam in 1957 had a major effect on Tribal fisheries. The Dalles Reservoir flooded Celilo Falls and inundated the site of a major Indian fishery that had existed for millennia. Commercial Indian landings at Celilo Falls from 1938 through 1956 ranged from 0.8 to 3.5 million pounds annually, based primarily on dip netting (ODFW and WDFW 1999). With the elimination of Celilo Falls, salmon harvest in the area declined dramatically. In 1957, in a joint action, the states of Oregon and Washington closed the Tribal fishery above Bonneville Dam to commercial harvesters. Treaty Indian fisheries that continued during 1957 through 1968 were conducted under Tribal ordinances. In 1968, with the Supreme Court opinion on the appeal of the Puyallup v. Washington case, the states reopened the area to commercial fishing by treaty Indians (ODFW and WDFW 1999).

Treaty Tribal and non-tribal fisheries in the Columbia River are currently managed under the ongoing Federal court jurisdiction of *U.S. v. Oregon*. The current *U.S. v. Oregon* 2005-2007 agreement defines harvest limitations on spring Chinook salmon based on total abundance of spring Chinook salmon returning to the Columbia Basin. This agreement currently limits the treaty Indian fishery impacts at 5-7 percent and the non-treaty impacts at 5 percent of the aggregate run (hatchery and natural) of all upriver spring Chinook (and spring/summer Chinook) at all run sizes up to a certain point. That point has not been reached in any year the plan has been in effect.

3.1.5 Effects of Natural Conditions on the Baseline

Changes in the abundance of salmonid populations are substantially affected by changes in the freshwater and marine environments. Recent evidence suggests that marine survival of salmonids fluctuates in response to 20- to 30-year cycles of climatic conditions and ocean productivity (Hare et al. 1999). This phenomenon has been referred to as the Pacific Decadal Oscillation. Also, large-scale climatic regimes, such as El Niño, appear to affect changes in ocean productivity and influence local environmental rainfall patterns that can result in drought and fluctuating flows. During the first part of the 1990s much of the Pacific Coast was subject to a series of very dry years and very low stream flows. In more recent years, severe flooding has adversely affected some stocks. The listed salmon species that occupy the Columbia River basin are affected by this broad environmental cycle; thus the survival and recovery of these species will depend on their ability to persist through periods of low natural survival rates.

Studies begun in 1997 by the Oregon Cooperative Fish and Wildlife Research Unit have shown that fish-eating birds that nest on man-made islands in the Columbia River estuary (Caspian terns, double-crested cormorants, and glaucous-winged gulls) are significant avian predators of juvenile salmonids. Researchers estimated that the single tern colony on Rice Island (16,000 birds in 1997) consumed 6 to 25 million outmigrating smolts during 1997 (Roby et al. 1998) and 7 to 15 million outmigrating smolts during 1998 (Collis et al. 1999). The observed levels of predation prompted the regional fish and wildlife managers to investigate the feasibility of management actions to reduce the impacts. Early management actions appear to have reduced predation rates; researchers estimate that terns consumed 7.3 million smolts during 1999 (Columbia Bird Research 2002), and all of the tern colony potentially destined for Rice Island in 2001 and 2002 has shifted downstream to East Sand Island. However, terns, cormorants, gulls, and pelicans nesting and roosting on other artificial islands in the estuary and hydropower reservoirs continue to consume many millions of smolts each year.

3.1.6 Effects of Scientific Research, Monitoring, and Enhancement

Like other ESA-listed fish, UCR spring Chinook salmon and steelhead are the subject of scientific research, monitoring, and enhancement activities. Most biological opinions that NMFS issues recommend specific monitoring, evaluation, and research projects to gather information to aid in the survival of the ESA-listed fish. In addition, NMFS has issued numerous research and/or enhancement permits authorizing takes of ESA-listed fish over the past 15 years. Each authorization for take by itself would not lead to decline of the species. However, the sum of the authorized takes indicate a high level of research effort in the action area, and as anadromous fish stocks have continued to decline, the proportion of fish handled for research/monitoring purposes relative to the total number of fish has increased. The effect of these activities is difficult to assess; nevertheless, the potential benefits to ESA-listed salmon and steelhead from the scientific information is likely to be greater than the potential risk to the species due to those efforts. Potential benefits include enhancing the scientific knowledge base for the species, answering questions or contributing information toward resolving difficult resource management issues, and directly enhancing the survival of the species. The information gained during research and monitoring activities is essential to assist resource managers in making more informed decisions regarding recovery measures. Moreover, scientific research, monitoring, and enhancement efforts were not identified as a factor for the decline of salmon and steelhead populations (70 FR 37160).

To reduce adverse effects from research and enhancement activities on the species, NMFS imposes conditions in its permits so that Permit Holders are required to conduct their activities in such a way as to minimize adverse effects on the ESA-listed species, including keeping mortalities as low as possible. Also, researchers are encouraged to use non-listed fish species and/or ESA-listed hatchery fish, instead of ESA-listed, naturally-produced fish, for scientific research purposes when possible. In addition, researchers are required to share sample fish, as well as the results of the scientific research, with other researchers as a way to avoid duplicative efforts and to acquire as much information as possible from the ESA-listed fish sampled. NMFS works with other agencies to coordinate research to prevent duplication of effort.

In general, for research and enhancement projects that require a section 10(a)(1)(A) permit, applicants will provide NMFS with high take estimates to compensate for potential in-season changes to research protocols, accidental catastrophic events, and the annual variability in ESA-listed fish numbers. Also, most research projects depend on annual funding and the availability of other resources. So, a specific research project for which take of ESA listed species is authorized by a permit may be suspended in a year when funding or resources are not available. Therefore, the actual take in a given year for most research and enhancement projects, as provided to NMFS in post-season annual reports, is usually less than the authorized level of take in the permits and the related NMFS consultation on the issuance of those permits. Therefore, because actual take levels tend to be lower than authorized takes, the severity of effects on ESA-listed species is usually less than the projected effects analyzed in a typical consultation.

A substantial amount of the annual take of ESA-listed salmon and steelhead is related to assessing the impact of the hydropower dams on the mainstem Columbia Rivers. Scientific research, monitoring, and enhancement activities are required by the Reasonable and Prudent Alternative of the opinion on the FCRPS (NMFS 2000a). The operation of PUD owned hydroelectric projects in the middle and upper Columbia River results in a substantial amount of annual take of ESA-listed spring Chinook salmon and steelhead for research purposes in the course of assessing impacts of operating those projects. For a description of the annual takes of ESA-listed salmon and steelhead associated with the hydropower dams on the mainstem Columbia River, refer to the recent biological opinions on operation of the Federal Columbia River Power System (NMFS 2004b) and PUD owned hydroelectric projects (NMFS 2003b, c and d).

3.2 Chinook Salmon Life Histories

Chinook salmon is the largest of the Pacific salmon. The species' distribution historically ranged from the Ventura River in California to Point Hope, Alaska, in North America, and in northeastern Asia from Hokkaido, Japan, to the Anadyr River in Russia (Healey 1991). Additionally, Chinook salmon have been reported in the Mackenzie River area of northern Canada (McPhail and Lindsey 1970). Of the Pacific salmon, Chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for Chinook salmon, seven total ages with three possible freshwater ages. This level of complexity is roughly comparable to that seen in sockeye salmon (*O. nerka*), although the latter species has a more extended freshwater residence period and uses different freshwater habitats (Miller and Brannon 1982, Burgner 1991). Two generalized freshwater life-history types were initially described by Gilbert (1912): "stream-type" Chinook salmon, which reside in fresh water for a year or more following emergence, and "ocean-type" Chinook salmon, which migrate to the ocean within their first year. Healey (1983, 1991) has promoted the use of broader definitions for "ocean-type" and "stream-type" to describe two distinct races of Chinook salmon. Healey's approach incorporates life history traits, geographic distribution, and genetic differentiation and provides a valuable frame of reference for comparisons of Chinook salmon populations.

3.2.1 Upper Columbia River Spring-run Chinook Salmon

The UCR spring-run Chinook salmon inhabit tributaries upstream from the Yakima River to Chief Joseph Dam. UCR spring-run Chinook salmon have a stream-type life history. Three independent populations of spring-run Chinook salmon are identified for the species: those that spawn in the Wenatchee, Entiat, and Methow River basins (Ford et al. 1999). Adults return to the Wenatchee River from late March through early May, and to the Entiat and Methow Rivers from late March through June. Most adults return after spending two years in the ocean, although 20 percent to 40 percent return after three years at sea. UCR spring-run Chinook salmon experience very little ocean harvest. Peak spawning for all three populations occurs from August to September. Smolts typically spend one year in freshwater before migrating downstream. There are slight genetic differences between this species and others containing stream-type fish, but more importantly, the DPS boundary was defined using ecological differences in spawning and rearing habitat (Myers et al. 1998). The Grand Coulee Fish Management Program (1939 through 1943) may have had a major influence on this species because fish from multiple populations were mixed into one relatively homogenous group and redistributed into streams throughout the upper Columbia River region.

3.3 Steelhead Life Histories

Steelhead can be divided into two basic run types based on their level of sexual maturity at the time they enter fresh water and the duration of the spawning migration (Burgner et al. 1992). The stream-maturing type, or summer steelhead, enters fresh water in a sexually immature condition and requires several months in fresh water to mature and spawn. The ocean-maturing type, or winter steelhead, enters fresh water with well-developed gonads and spawns relatively shortly after river entry (Barnhart 1986). Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead; others only have one run type. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death. However, it is rare for steelhead to spawn more than twice before dying, and most that do so are females (Nickelson et al. 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby et al. 1996). Multiple spawnings for steelhead range from three percent to 20 percent of runs in Oregon coastal streams, though they are rare in upper river areas—especially above the mainstem Columbia River dams. Steelhead spawn in cool, clear streams with suitable gravel size, depth, and current velocity. Intermittent streams may also be used for spawning (Barnhart 1986, Everest 1973).

3.3.1 Upper Columbia River Steelhead

UCR steelhead inhabit the Columbia River reach and its tributaries upstream of the Yakima River. This region includes several rivers that drain the east slopes of the Cascade Mountains and several that originate in Canada (only U.S. populations are included in the listed species). Dry habitat conditions in this area are less conducive to steelhead survival than in many other parts of the Columbia River basin (Mullen et al. 1992a). Although the life history of these fish is similar to that of other inland steelhead, smolt ages are some of the oldest on the West Coast (up to seven years old), probably due to the ubiquitous cold water temperatures (Mullen et al. 1992b). Adults spawn later than in most downstream populations, remaining in fresh water up to a year before spawning. Most current natural production occurs in the Wenatchee and Methow River systems, with a smaller run returning to the Entiat River (WDF et al. 1993). Very limited spawning also occurs in the Okanogan River basin. Most of the fish spawning in natural production areas are of hatchery origin.

3.4 Status of the Species in the Action Area

Environmental baselines for biological opinions are defined by regulation at 50 CFR §402.02, which states that an environmental baseline is the physical result of all past and present state, Federal, and private activities in the action area along with the anticipated impacts of all proposed Federal projects in the action area (that have already undergone formal or early section 7 consultation). The environmental baseline for this Opinion is therefore the result of the impacts that activities (summarized below) have had on the various listed species' survival and recovery in the Action Area. The baseline is the culmination of these effects on the primary constituent elements that are essential to the conservation of the species that occur in the Action Area.

To determine a species' status under extant conditions (usually termed "the environmental baseline"), it is necessary to ascertain the degree to which the species' biological requirements are being met at that time and in that action area. For the purposes of this consultation, the species' biological requirements are expressed in two ways: Population parameters such as fish numbers, distribution, and trends throughout the action area; and the condition of various essential habitat features such as water quality, stream substrates, and food availability. Clearly, these two types of information are interrelated. That is, the condition of a given habitat has a large impact on the number of fish it can support. Nonetheless, it is useful to separate the species' biological requirements into these parameters because doing so provides a more complete picture of all the factors affecting the species' survival. Therefore, the discussion to follow will be divided into two parts: Species Distribution and Trends, and Factors Affecting the Environmental Baseline in the Action Area. Additionally, the proposed hatchery program is intended to directly affect a specific segment of one population of spring Chinook salmon. Therefore it is necessary to assess the current condition of that population segment, which is the White River spawning aggregate, prior to evaluating the potential impacts of the proposed action.

3.4.1 UCR Chinook

Information on the status and distribution of UCR spring Chinook salmon is found in the status review prepared by the NWFSC, NMFS (Myers et al. 1998). More recent information on the status and distribution of the Chinook salmon species, including hatchery components of the respective populations, is provided in the status review update prepared by the West Coast Chinook Salmon Biological Review Team (NMFS 1998a), the Evaluation of the Status of Chinook and Chum Salmon and Steelhead Hatchery Populations for ESUs Identified in Final Listing Determinations prepared by the Conservation Biology Division of the NWFSC (NMFS 1999b), in the Preliminary Conclusions Regarding the Updated Status of Listed ESUs of West Coast Salmon and Steelhead (NMFS 2003e), and from ICTRT documents (ICTRT 2007). The discussions in these documents are summarized here.

There are no estimates of historical abundance specific to this species prior to the 1930s. The drainages supporting this species are all above Rock Island Dam on the upper Columbia River. Rock Island Dam is the oldest major hydroelectric project on the Columbia River; it began operations in 1933. Counts of returning Chinook have been made since the 1930s. Annual estimates of the aggregate return of spring Chinook to the upper Columbia are derived from the dam counts based on the nadir between spring and summer return peaks. Spring Chinook salmon currently spawn in three major drainages above Rock Island Dam—the Wenatchee, Methow and Entiat Rivers. Historically, spring Chinook may have also used portions of the Okanogan River. Approximately 50 percent of the area that produced UCR spring Chinook salmon is above Chief Joseph Dam and is not accessible to anadromous fish.

The 1998 Chinook Status Review (Myers et al. 1998) reported that long-term trends in abundance for upper Columbia spring Chinook populations were generally negative, ranging from -5 to +1 percent. Analyses of the data series, updated to include 1996-2001 returns, indicate that those trends have continued. The long-term trend in spawning escapement is downward for all three systems. The Wenatchee River spawning escapements have declined an average of 5.6 percent per year, the Entiat River population at an average of 4.8 percent, and the Methow River population an average rate of 6.3 percent per year since 1958 (NMFS 2003e).

In the 1960s and 1970s, spawning escapement estimates were relatively high with substantial year-to-year variability. Escapements declined in the early 1980s, then peaked at relatively high levels in the mid 1980s. Returns declined sharply in the late 1980s and early 1990s. The 1990-1994 returns were at the lowest levels observed in the 40-plus years of the data sets. The Upper Columbia Biological Requirements Workgroup (Ford et al. 2001) recommended interim delisting levels of 3,750, 500, and 2,200 spawners for the populations returning to the Wenatchee, Entiat, and Methow drainages, respectively. Five-year geometric mean spawning escapements from 1997 to 2001 were at 8-15 percent of these levels. Target levels have not been exceeded since 1985 for the Methow run and the early 1970s for the Wenatchee and Entiat populations (NMFS 2003e).

Short-term population growth rates for the three extant populations in the UCR reported in the 1998 Status Review (Myers et al. 1998) ranged from -15.3 percent (Methow R.) to -37.4 percent (Wenatchee R.). The escapements from 1996-1999 reflected that downward trend. However, escapements increased substantially in 2000 and 2001 in all three systems. Returns to the Methow River and the Wenatchee River reflected the higher return rate on natural production as well as a large increase in contributions from supplementation programs. However, short-term trends (1990-2001) in natural returns remained negative for all three upper Columbia spring Chinook populations. Natural returns to the spawning grounds for the Entiat, Methow, and Wenatchee River populations continued downward at average rates of 3, 10, and 16 percent, respectively (NMFS 2003e). And finally, after record- or near-record escapements in 2001 for both natural and hatchery fish, the trend was again downward for the last two years of available data.

The Wenatchee population of spring Chinook salmon includes five spawning aggregates; Chiwawa River, Nason Creek, upper Wenatchee River, White River, and Little Wenatchee River.

The White River spring Chinook salmon spawning aggregate is severely depressed and persistently experiences escapement levels below critical population thresholds. Myers et al. (1998) reported geometric mean escapement of 25 spawning adults between 1990 and 1994 with a negative short-term population abundance trend of –35.95 and negative long-term trend of –10.6 percent. More recently, the West Coast Salmon Biological Review Team (WCSBRT 2003) reported a continued negative short-term abundance trend with a 1997-2001 abundance trend of -6.6 percent and geometric mean of nine redds.

The White River aggregate is the most genetically unique among those spawning in tributaries within the ESU (Utter et al. 1995, Ford et al. 2001, McClure et al. 2003). An updated genetic evaluation (microsatellite analysis) of the White River aggregate and other spawning aggregates in the Wenatchee basin began in 2004 and is supported through a reproductive success study funded through Bonneville Power Administration (BPA Project No. 2003-0399-00). Analysis of 2004 and 2005 reproductive success data indicates that the White River spawning aggregate continues to represent a distinct sub-population in the Wenatchee River Basin (Murdoch et al. 2006).

A minimum Viable Salmon Population (VSP) abundance level for the Wenatchee River population of the UCR spring Chinook salmon ESU was set at 2,000 natural origin fish by the ICTRT (2007). Based on the historic distribution of spring Chinook salmon redds in the Wenatchee River basin from 1956 to 2003, the average percentage of redds in the White River was 7.3 percent. Using the minimum abundance level of 2,000 and assuming that the redd counts reflect an appropriate distribution for the population, then 7.3 percent or an average of 146 adults should be spawning in the White River to meet minimum recovery levels.
White River spring Chinook salmon natural origin adult returns ranged between 2 to 404 since 1981 (Table 1) with the highest returns occurring in the 1980s. Since 1981, the White River aggregate has demonstrated a decline, followed by a recent improvement. A change to more favorable ocean rearing conditions may account for some of the improvement. Future adult returns may again become depressed due to declining ocean conditions.

Table 1. Spring Chinook salmon natural origin returns to the White River during 1981 through 2005.

Year	Adults	Year	Adults	Year	Adults	Year	Adults	Year	Adults
1981	60	1986	204	1991	49	1996	26	2001	158
1982	180	1987	99	1992	78	1997	33	2002	68
1983	308	1988	139	1993	132	1998	11	2003	33
1984	181	1989	141	1994	7	1999	2	2004	61
1985	404	1990	49	1995	4	2000	21	2005	49

Fish spawning sites (redds) during the period of 1990 – 2005 showed a similar general decline, followed by a recent improvement (Table 2). The White River natural origin redd count shows a general downward trend in the percentage of redds from the historical level when compared to the total redds counted in the Wenatchee River basin (6.6 percent for 1990-2005, 6.3 percent for 1995-2005 and 4.5 percent for 2000-2005).

Table 2. Spring Chinook salmon redd counts in the entire Wenatchee basin[a] and White River for 1990 through 2005.

Year	Wenatchee Basin Total	White River	Year	Wenatchee Basin Total	White River	Year	Wenatchee Basin Total	White River
1990	446	22	1996	72	12	2002	748	33 [b]
1991	251	21	1997	175	15	2003	249	14 [b]
1992	491	35	1998	83	5	2004	492	20 [b]
1993	447	60	1999	48	1	2005	629	27 [b]
1994	125	3	2000	282	8			
1995	23	2	2001	1,795	99 [b]			

[a] *Includes redd counts from Chiwawa, Little Wenatchee, Upper Wenatchee, White Rivers and Nason Creek*

[b] *White River natural origin redds count estimate adjusted for stray rates*

The VSP criteria state that the population growth rate should exceed a 1.0 natural return ratio per generation and should equal at least 1.0 for recovered populations (McElhany et al. 2000, Ford et al. 2001). Previous status reviews have indicated that short-term population growth rates in the Wenatchee River population averaged –37.4 percent between 1977 and 1995 and continued to decline at –16 percent between 1990 and 2001 (Myers et al. 1998, WCSBRT 2003). The short-term growth rates for the White River for the same periods were –35.9 percent and –6.6 percent respectively. Returns per spawner in the White River have averaged 1.37 over a 20-yr period between 1981 and 2000 with seven of 20 years showing a positive return-per-spawner.

The effectiveness of this program will ultimately be mediated by the production potential of naturally spawning adults from this recovery program. Adult returns from the program have the potential to relieve some dispensatory pressure in the White River, including mate location and selection, nutrient enhancement from increased carcass deposition, and cleaning of impacted spawning gravel. The monitoring activities proposed in this application would provide important information to evaluate productivity and population growth rate in response to the supplementation program.

3.4.2 UCR Steelhead

Recent years have seen an encouraging increase in the number of naturally produced fish in the Upper Columbia River steelhead DPS. On January 5, 2006 NMFS published a determination that changed the listing status of this DPS from Endangered to Threatened (71 FR 834).

The 1996–2001 average return through the Priest Rapids Dam fish ladder (just below the upper Columbia steelhead production areas) was approximately 12,900 total adults (including both hatchery and natural origin fish), compared to 7,800 adults for 1992– 1996. However, the recent 5-year mean abundances for naturally spawned populations in this DPS are 14 to 30 percent of their interim recovery target abundance levels. Little is known about the productivity of the natural populations. At this time, the low replacement rate of naturally spawning fish estimated when the steelhead were initially listed under the ESA (0.25–0.30 at the time of the last status review in 1998) does not appear to have appreciably improved (Good et al. 2005). Hatchery-origin steelhead continue to dominate the natural spawning populations (approximately 70 to 90 percent of adult returns) and generates uncertainty in evaluating trends in natural abundance and productivity. The natural component of the anadromous run over Priest Rapids Dam has increased from an average of 1,040 (1992–1996) to 2,200 (1997–2001). The mean proportion of natural-origin spawners declined by 10 percent from 1992–1996 to 1997–2001. The BRT (Good et al. 2005) found high risk to the DPS's productivity, with comparatively lower risk to the DPS's abundance, diversity, and spatial structure. Six artificial propagation programs that produce hatchery steelhead in the Upper Columbia River Basin are considered to be part of the Upper Columbia River steelhead DPS. These programs are intended to contribute to the recovery of the DPS by increasing the abundance of natural spawners, increasing spatial distribution, and improving local adaptation and diversity (particularly with respect to the Wenatchee River steelhead).

Research projects to investigate the spawner productivity of hatchery-reared fish are being developed. Some of the hatchery-reared steelhead adults that return to the basin may be in excess of spawning population needs in years of high survival conditions, potentially posing a risk to the naturally spawned populations in the DPS. The artificial propagation programs included in this DPS adhere to strict protocols for the collection, rearing, maintenance, and mating of the captive brood populations. The programs include extensive monitoring and evaluation efforts to continually evaluate the extent and implications of any genetic and behavioral differences that might emerge between the hatchery and natural stocks. Genetic evidence suggests that these hatchery stocks remain closely related to the naturally spawned populations and maintain local genetic distinctiveness of populations within the DPS.

The BRT (Good et al. 2005) found that the effects of artificial propagation on the DPS's extinction risk concluded that hatchery programs collectively mitigate the immediacy of extinction risk for the Upper Columbia River steelhead DPS in the short term, but that the contribution of these programs in the foreseeable future is uncertain.

The Wenatchee River basin is the primary habitat for adult steelhead returning between Rock Island and Wells Dams. The average steelhead escapement to the Wenatchee River Basin during the recent 5-year period (2001-2005) is estimated at 4,631 fish, compared to the previous 5-year mean of 1,361 fish (Table 3). Within the Wenatchee River Basin, spawning aggregates occupy the mainstem Wenatchee River, Chiwawa River, Nason Creek and to a much lesser extent the Little Wenatchee and White rivers (Table 4). Based on 2001-2005 steelhead redd abundance and distribution in the Wenatchee River Basin, the White River spawning aggregate was just 0.2 percent of the overall steelhead redd deposition in the Wenatchee River Basin (Table 4).

Table 3. Upper Columbia River steelhead dam passage counts and estimated escapement to the Wenatchee basin from 1990 through 2005 based on dam passage counts.

Run Year [1]	Rock Island Dam	Rocky Reach Dam	Estimated Escapement
1990	6,915	5,004	1,911
1991	11,217	7,884	3,333
1992	12,382	7,429	4,953
1993	4,689	2,737	1,952
1994	5,626	2,823	2,803
1995	4,168	1,777	2,391
1996	7,295	5,780	1,515

1997	7,718	6,756	962
1998	4,967	4,404	563
1999	6,345	4,845	1,500
2000	10,554	8,289	2,265
2001	28,614	22,103	6,511
2002	15,243	11,715	3,528
2003	17,623	13,770	3,853
2004	19,448	14,613	4,835
2005	12,410	9,480	2,930

[1] *Run year is the combined total of steelhead passing from 1 June - 30 November during year (x), plus steelhead passing between April 15 - May 31 on year (x+1)*

Table 4. Wenatchee basin upper Columbia steelhead redd counts by sub-basin from 2001 through 2005 (Tonseth 2006).

	Survey Year						2001-2005	Average
Basin/Sub-basin	**2001**	**2002**	**2003**	**2004**	**2005**	**Total**	**Average**	**Proportion**
Wenatchee Mainstem [1]	116	315	248	151	459	1289	258	0.460
Icicle Creek	19	27	16	23	8	93	19	0.033
Peshastin Creek [2]			15	34	97	146	49	0.087
Chiwawa River [2]	25	80	64	62	162	393	79	0.140
Nason Creek [2]	27	80	121	127	412	767	153	0.274
Little Wenatchee River		1	5	0	0	6	2	0.003
White River [2]		0	3	0	2	5	1	0.002
Wenatchee Basin Total	**187**	**503**	**472**	**397**	**1140**	**2699**	**560**	**1.000**

[1] *Includes Beaver Creek and Chiwaukum Creek*
[2] *Includes tributaries*

Thus, the degree to which the biological requirements of UCR spring Chinook salmon and steelhead are being met in the action area (with respect to population numbers and distribution) is something of a mixed bag—though the picture is generally a poor one. While some improvement for all species can be seen since the mid 1990s (especially in 2001), the species are still at critically low levels compared to both historic production and the desired escapement levels. Therefore, the most likely scenario is that their biological requirements are not being met with respect to abundance, distribution, or overall trend.

3.5 Status of Critical Habitat in the Action Area

NMFS designated Critical Habitat for UCR spring Chinook salmon on September 2, 2005 (70 FR 52630). Critical habitat in the action area includes the White River at Lake Wenatchee upstream to endpoints in Napeequa River, Panther Creek, and the White River. Critical habitat includes the stream channels within the designated stream reaches, and includes a lateral extent as defined by the ordinary high-water line (33 CFR 319.11). In areas where ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge which generally has a recurrence interval of 1 to 2 years in the annual flood series.

Lake Wenatchee is also designated critical habitat for UCR spring Chinook salmon defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of ordinary high-water, whichever is greater.

The following description of the White River basin and Lake Wenatchee was modified from the Wenatchee Subbasin Plan (Johnson 2004).

The White River is one of the two primary tributaries that flow into Lake Wenatchee. The drainage encompasses 99,956 acres and originates in alpine glaciers and perennial snow fields. Many White River head water sources are at higher elevation than the highest elevation in the Little Wenatchee drainage (Andonaegui 2001). The White receives more precipitation, and sustains higher summer flows and cooler summer temperatures than the Little Wenatchee. Precipitation ranges from 30 inches at the mouth to more than 140 in. in the head-waters (Andonaegui 2001). The White River flows south-southeast for the majority of its length (26.7 river miles). Two large tributaries, Napeequa (RM 11.0) and Panther (RM 13.1) creeks, support anadromous salmonids. Sears (RM 7.7) and Canyon (RM 10.0) creeks, two smaller tributaries to the mainstem, support bull trout only (Andonaegui 2001; Mullan et al. 1992b). Of the total acreage in the drainage, 78 percent is in public ownership and 22 percent in private ownership, all in the lower third of the river below Panther Creek (Andonaegui 2001). Over half of the watershed is contained within wilderness. The upper 15 miles of the White River are located entirely within the Glacier Peak Wilderness (Andonaegui 2001).

The White River drainage is among the healthiest in the Columbia basin. Several habitat concerns, however, exist (Andonaegui 2001). The mainstem below the wilderness boundary has had some alteration and consequently many habitat indicators exist in only fair condition. The most altered area is in the lower watershed below Panther Creek. Changes have resulted from floodplain development and impacts on riparian areas from historic cedar logging and roading. On private lands development of homes and vacation retreats is occurring.

The mainstem below White River Falls is a key spawning and migration corridor for spring Chinook salmon, sockeye, and bull trout. Spawning areas in the White River remain functional, where most geofluvial processes have not changed over time and spawning gravels and water flow are in good condition. Incubation of eggs is most likely not affected by human-caused factors in the White River (Johnson 2004).

Four tributaries entering the White River below RM 13 support Chinook salmon, steelhead or bull trout; Panther Creek (RM 13.1), Napeequa (RM 11.0), Canyon Creek (RM 10.0), and Sears Creek (RM 7.7). Despite historic floodplain conversion and development, high quality habitat and connectivity remains among White River, Panther and Napeequa populations. Increasing floodplain development in the privately owned lower valley continues to be of concern for off-channel habitat, refugia, streambank condition, floodplain connectivity, riparian reserves, large woody debris, and road density/location.

Lake Wenatchee is a large, steep-sided lake covering about 2,480 acres with a volume of about 364,560 acre-feet or water. A large wetland is at the western end of the lake at the deltas of the Little Wenatchee and White Rivers. A terminal glacial moraine at the east end of the lake is the natural dam that formed the lake. Portions of the lake normally freeze over during the winter months and strong winds keep the lake mixed during much of the other seasons.

Lake Wenatchee has been classified limnologically as an oligotrophic lake (Ecology 1997), and characterized in the Wenatchee Subbasin Plan as generally lacking in phosphorous, nitrogen, and chlorophyll a (Johnson 2004). Average summer time Secchi readings were estimated at 20 feet and a single Chlorophyll a recording of 1.7 µg/l (Ecology 1997) suggests low primary and secondary productivity. More recent water quality sampling by Ecology during 2002 and 2003 indicates limited periphyton biomass due to generally low nitrogen and phosphorous levels in the Wenatchee River from River Mile (Rm) 17 to Rm 54 (Lake Wenatchee outlet)(Ecology 2006). These data may be an indicator of nutrient levels in Lake Wenatchee and suggest that Lake Wenatchee continues to be in an oligotrophic state.

Land ownership of shoreline properties around Lake Wenatchee is 45.3 percent Federal, 12.2 percent State, 0.5 percent Chelan County, and 42.0 percent private. The majority of private land is developed for residential (approximately 290 single-family homes) use along the north and south shores (CCNRP 2003).

The extent to which spring Chinook salmon rear or over winter in Lake Wenatchee is not known. However, the lake is at a minimum, an important migration corridor for spring Chinook salmon originating in the White River and Little Wenatchee River.

3.6 Factors Affecting the Environmental Baseline in the Action Area

The primary constituent elements for listed species can be expressed in terms of the sites essential to supporting one or more of the species' life stages. These sites, in turn, contain physical and biological features essential to conserving the species. The specific primary constituent elements as defined in the Federal Register (70 FR 52630) include:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.

2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic

vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.

6 . Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation.

Considering only those primary constituent elements for listed species that occur in the Action Area, only the first three elements listed above apply to this Opinion.

Assessment of the habitat in the White River basin was done as part of the development of the Wenatchee Watershed Plan (Johnson 2004). That plan summarized the water quality and quantity to be at or near pristine conditions for the basin (Johnson 2004). Including reporting that the White River has been the coldest stream monitored in the Wenatchee subbasin since 1995 (Johnson 2004).

The following human impacts were described in the Wenatchee Watershed Plan (Johnson 2004). The White River drainage has had minimal riparian harvest from the 1950s to the present on federal land. Turn of the century settlement and land clearing has impacted the riparian reserve network up to Napeequa confluence. Riparian condition in the mainstem below Panther Creek is fair. In the remainder of the watershed, woody debris recruitment, shade, aquatic habitat connectivity, and riparian vegetation appear to be in natural condition, and are in good condition. Disruption of the vegetative continuity along riparian areas is a result of site conversion on both private and public lands, grazing, and road building. Noxious weeds in riparian areas are also a concern and are found in most accessible riparian areas. Land development in the lower mainstem has reduced some floodplain function. The greatest future threat to salmonid production is additional floodplain development. Off-channel habitat is fair in the watershed below Panther Creek and good for the remainder of the watershed, including Panther, Indian, and Napeequa tributaries. Roads in riparian areas also contribute to loss of riparian habitat function downstream of RM 11.0 (Andonaegui 2001). Nearly half of the road miles are located in this floodplain (Driscoll et al. 1998; Andonaegui 2001).

The White River has sections of riprap and bank erosion associated with roads, bridges, dispersed recreation, and other development. There are short sections of riprap and/or bank erosion associated with roads, bridges, dispersed recreation, or other development along the lower Napeequa River, the largest tributary to the White River (Johnson 2004). Bank disturbance totals 4 percent for the lower two miles of Napeequa surveyed in 1996 (MacDonald et al. 1996). Overall streambanks are in good condition (Andonaegui 2001). With most of the riparian, floodplain, and channel condition in good or fair condition, high flows are not a concern in the watershed. All streams in the watershed are good condition in terms of pool depth and pool quality (Andonaegui 2001). No human induced fish passage impediments were identified in the White River basin (Johnson 2004).

In general, the White River was determined to have abundant, good quality side channel and oxbow habitat. However, lower sections have areas of riprap and/or active bank erosion associated with roads, bridges, dispersed recreation or other development (Johnson 2004).

Factors outside the Action Area have contributed to the decline of UCR spring Chinook salmon and UCR steelhead by adversely affecting the primary constituent elements. These factors are well known and documented in dozens—if not hundreds—of scientific papers, policy documents, news articles, books, other media, and were summarized above in section 3. Factors such as hydropower, agricultural development have had adverse effects on every single one of the habitat-related biological requirements listed above, while other factors have only affected some of those essential habitat features. For example, road building in the Columbia River basin has had a sizeable effect on stream substrates and water quality (through siltation), and road culverts have blocked fish passage, but such activities have not had much of an effect on water velocity. In another instance, timber harvest and grazing activities have affected—to greater or lesser degrees—all the factors except space. And urban development has affected them all, but generally to a small degree in the largely rural basin. In short, nearly every widespread human activity in the basin has adversely affected some or all of the habitat features listed above. And by disrupting those habitat features, these activities—coupled with hatchery and fishery effects and occasional natural disturbances such as drought and fire—have had detrimental impacts on all the species' health, physiology, numbers, and distribution in every subpopulation and at every life stage. However, because these impacts are outside the Action Area, it is unnecessary to detail them in this Opinion. For detailed information on how various factors have degraded essential habitat features in the Columbia River basin please see any of the following: NMFS (1991), NMFS (1997), NMFS (1998b), NMFS (2000a, b), NMFS (2002b), and NMFS (2003e).

4 EFFECTS OF THE PROPOSED ACTIONS

NMFS analyzes the direct and indirect effects of an action on the species or its critical habitat, together with the effects of other activities that are interrelated or interdependent with that action that will be added to the environmental baseline. Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur. Interrelated actions are those that are part of a larger action and depend on the larger action for the justification. Interdependent actions are those that have no independent utility apart from the action under considerations (50 CFR §402.02).

The activities would be (a) collection of eggs or fry from naturally spawning spring Chinook salmon in the White River, (b) rearing of those eggs or fry to mature adults, (c) spawning of those adults in a hatchery environment, (e) rearing of the resultant progeny to a pre-smolt stage in a hatchery facility, (d) final rearing and release of yearling smolts in the White River basin, (f) monitoring of the juveniles released and naturally produced in the White River, and (g) monitoring of both hatchery and naturally produced adults returning to the White River.

4.1 Effects on Critical Habitat

Previous sections have discussed the scope of the salmonid habitat in the action area, described the habitat's primary constituent elements, and depicted its present condition. This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, this critical habitat analysis determines whether the proposed action will destroy or adversely modify designated critical habitat for listed species by examining any change in the conservation value of the essential features of that critical habitat. This analysis relies on statutory provisions of the ESA that define "critical habitat" and "conservation," describe the designation process, and that set forth the substantive protections and procedural aspects of consultation. The regulatory definition of "destruction or adverse modification" at 50 CFR 402.02 is not used in this Opinion (Hogarth 2005). The discussion here focuses on how the primary constituent elements are likely to be affected by the proposed actions.

4.1.1 Collection of Egg or Fry

The collection of eggs would be done by injected water mixed with air into the gravel mound of a naturally constructed redd. This could displace any sediment that had accumulated in the gravel since redd construction was completed. Displaced sediment would be transported downstream and resettle in a manner similar to what occurs naturally when salmon build redds. The eggs collected would be removed from this risk, but eggs that remain in redds below the sampled redd could be impacted by the displaced sediment. The activity does not add sediment to the environment and the amount of displaced sediment would be small because the initial activity of constructing the redd would have already cleaned the gravel of most sediment.

The collection of fry would occur at a juvenile trap site, such as a rotary screw trap. The placement and daily access to the trap could impact riparian vegetation depending on the trap location. If the trap location is adjacent to intact riparian habitat, a foot path would likely used to access the trap. Over the course of several weeks, a foot path may become established and the re-growth of vegetation prevented until the trapping activity stops. If the trapping activity stopped, the vegetation impacted would likely be restored with a few weeks or months.

If the rotary trap is located in an area already disturbed because of bridge, road or previous placement of riprap, then no further degradation of habitat would be expected. Typical installations of rotary traps in other rivers in the Wenatchee basin are near roads, some are at bridges where habitat was previously disturbed (i.e., upper and lower Wenatchee River trap sites). A rotary trap site in the Chiwawa River has had bank erosion likely from a combination of the river migration in the floodplain and the disturbance of riparian vegetation at the site. At this site the bank has been stabilized using large boulders and replanted with native plants.

Terms and conditions effectively minimize the potential impacts on intact riparian habitat associated with egg and fry collection. NMFS concludes that the potential minor impacts would not appreciably alter the primary constituent elements of the sites essential to supporting one or more of the species' life stages or the physical and biological features essential to conserving the species.

4.1.2 Rearing of Eggs/Fry to Adult

The rearing of eggs or fry to maturity would occur at already established hatchery facilities outside the White River basin. Therefore, no impact on any habitat in the Action Area would occur.

4.1.3 Spawning of Adults in Captivity

The spawning of adult raised in captivity would occur at already established hatchery facilities outside the White River basin. Therefore, no impact on any habitat in the Action Area would occur.

4.1.4 Rearing Resultant Progeny in Hatchery

The rearing of progeny from adults raised in captivity would occur at already established hatchery facilities outside the White River basin. Therefore, no impact on any habitat in the Action Area would occur.

4.1.5 Final Rearing/Acclimation and Release in Natural Environment

The final rearing of juvenile fish and release of fry or yearling smolts in the White River could impact habitat in the Action Area. Potential impacts include disturbance of riparian vegetation, water withdrawal, and water quality impacts from water used to rear fish.

Although no specific location has been identified yet in the White River basin where temporary facilities, such as portable ponds, could be used, NMFS considered the general impacts that could occur if a suitable location was found. Temporary ponds, if used, would be maintained for about 8 weeks during March to April. The installation of such ponds could impact vegetation above the ordinary high-water mark that delineates critical habitat. Vegetation in the area directly beneath and immediately surrounding temporary ponds would likely be killed during the few months of impact. If temporary ponds are left in place for the duration of this permit, then vegetation would be killed. In both cases, these areas are outside the defined critical habitat areas and further, these areas would be expected to re-vegetate quickly once the temporary structures are removed because no permanent alterations to the land, such as application of concrete, asphalt or other material that would inhibit plant growth would occur. Additionally, some form of water intake and egress for both water and fish would be necessary that could impact a segment of riparian habitat. The impact would be in the form of crushing vegetation at the site of water withdrawal and return. The linear dimension of such impact would be expected to be minimal. As mitigation for impacts to riparian habitat, permit 1592 terms and conditions would require the permit holders to restore riparian areas equal or greater to the impacted area.

Final rearing and release of program fish would occur between March and May when water flows are increasing due to snow melt. The average White River flows in 2003-2006 were 402, 832, and 1,675 cfs in March, April, and May, respectively. Using a temporary facility in the White River basin for up to eight weeks between March and May in the late winter-early spring would result in diverting less than 2 percent of the average monthly flow from the White River, which would subsequently be returned to the White River near the same location as the diversion.

Water quality might be affected by effluent from the artificial propagation activities; any temporary hatchery facility would be required to operate under National Pollutant Discharge Elimination System (NPDES) permits issued by the U.S. Environmental Protection Agency. Hatchery effluent standards and point source discharge criteria are set forth in the NPDES permit to protect aquatic life and the habitat in the area below the discharge points. To monitor water quality and the impacts of hatchery effluent, the facility operators would monitor total suspended solids, settleable solids, upstream and downstream temperatures, and upstream and downstream dissolved oxygen. Considering that the effluent produced from hatchery facilities must comply with Environmental Protection Agency standards, coupled with the low percentage (less than 1:20) of effluent to discharge (dilution factor) that would exist, there is a low possibility that effluent produced at a temporary facility would negatively impact the physical environment. The permit would include terms and conditions that require the program operators to obtain and comply with the above permits and standards.

An alternative rearing and acclimation strategy for the proposed program would be using net pens in Lake Wenatchee. Potential impacts from this strategy would be restricted to water quality (i.e., no riparian impacts would occur, and not water would be withdrawn).

In a low-nutrient water body such as Lake Wenatchee (oligotrophic status), it is unlikely that a relatively small amount of low phosphorous feed inputted over a short time period would have a measurable impact on the overall water quality of Lake Wenatchee. Recent preliminary water quality data related to the sockeye net pen program in Lake Wenatchee indicates that phosphorous levels near the pens during operation are lower than the confluence areas of the little Wenatchee and White Rivers and of those "mid-lake." Therefore, a small input of nutrients would not have a negative effect on the lake environment.

Therefore, NMFS concludes that the proposed final rearing and release of fish are not likely to have an adverse impact on any salmonid habitat in the Action Areas and thus would not jeopardize any of the listed fish by reducing the ability of that habitat to contribute to their survival and recovery. Critical habitat would not be destroyed nor adversely modified by any of the juvenile monitoring actions being contemplated in this Opinion.

4.1.6 Monitoring of Juveniles in Natural Environment

Monitoring of juvenile spring Chinook salmon in the natural environment would be conducted using standard monitoring techniques such as snorkel surveys in spawning and rearing habitat, capturing fish with traps, and nets of various types, and marking the captured fish with various types of identifying marks or tags. All of these techniques are minimally intrusive in terms of their effect on habitat (NMFS 2006). None of them will measurably affect any of the three primary constituent elements essential to the conservation of the listed species that occur in the Action Area. Moreover, the proposed activities are all of short duration. Therefore, NMFS concludes that the proposed activities are not likely to have an adverse impact on any salmonid habitat in the action areas and thus would not jeopardize any of the listed fish by reducing the ability of that habitat to contribute to their survival and recovery. And, that critical habitat would not be destroyed nor adversely modified by any of the juvenile monitoring actions being contemplated in this Opinion.

4.1.7 Monitoring of Adults in Natural Environment

Monitoring of adult spring Chinook salmon in the natural environment would be conducted using standard monitoring techniques such as snorkel surveys, redd counts, and carcass surveys. All of these techniques are minimally intrusive in terms of their effect on habitat. None of them will measurably affect any of the three primary constituent elements essential to the conservation of the listed species that occur in the Action Area. Moreover, the proposed activities are all of short duration.

Therefore, NMFS concludes that the proposed activities are not likely to have an adverse impact on any salmonid habitat in the action areas or reduce the functionality of any primary constituent element and thus would not jeopardize any of the listed fish by reducing the ability of that habitat to contribute to their survival and recovery. Critical habitat would not be destroyed or adversely modified by any of the juvenile monitoring actions being contemplated in this Opinion.

4.2 Effects on Salmonids

In this section, we evaluate the expected impacts of the proposed action on listed salmon and steelhead in the action area. Because the proposed program would propagated listed fish, this analysis must consider the risks to fish in the program as well as listed fish in the natural environment. The steps used in this consultation to evaluate the risks artificial propagation programs pose to listed species are a refined version of the procedures used in NMFS (1995a) and NMFS (1999a), incorporating scientific information that continues to be developed. The *Biological Opinion on Artificial Propagation in the Columbia River* (NMFS 1999a), the *Biological Opinion on Effects of the Upper Columbia River Spring Chinook Salmon Supplementation Program and Associated Scientific Research and Monitoring Conducted by the Washington Department of Fish and Wildlife and the U.S. Fish and Wildlife Service* (NMFS 2002a), *Biological Opinion on Artificial Propagation in the Hood Canal and Eastern Strait of Juan de Fuca Regions of Washington State* (NMFS 2002c), and the *Biological Opinion on Artificial Propagation of non-listed species in the Upper Columbia River region of Washington State* (NMFS 2003a), identify multiple general types of potential adverse effects of hatchery operations and production on population viability. These were listed above in the Overview of Artificial Propagation section. This analysis will consider those general risks: (1) operation of hatchery facilities, (2) broodstock collection, (3) genetic introgression, (4) disease, (5) competition/density-dependent effects, (6) predation, (7) residualism, (8) nutrient cycling, (9) masking, (10) fisheries, and (11) monitoring and evaluation/research. A full discussion of each of these types of potential impacts is provided in the documents listed above. This Opinion considers the potential impacts of the artificial propagation program in a manner consistent with the previously issued biological opinions listed above.

4.2.1 Operation of Hatchery Facilities

Potential risks to listed natural salmonids associated with the operation of hatchery facilities include:
1. Hatchery facility failure (power or water loss leading to catastrophic fish losses).
2. Hatchery water intake impacts (stream de-watering and fish entrainment).
3. Hatchery effluent discharge impacts (deterioration of downstream water quality).

The actual impacts that hatchery facility operations can have on listed fish depend on the likelihood that the hatchery operation will interact with juvenile or adult fish, and whether the program is operated to minimize the risk of adverse impacts on listed fish. Since the program would be propagation listed fish, impacts could occur in any hatchery facilities and to listed fish in the natural environment.

The proposed program would not result in the construction or use of any permanent hatchery facilities in the White River basin. Temporary rearing and release facilities such as portable ponds or net pens would be used for about 8 weeks in March to April, annually. As previously stated, the hatchery facilities outside the White River basin have already been or are being considered in separate ESA consultations so they are not analyzed in this Opinion, but they are part of the baseline.

<u>Hatchery Facility Failure:</u> This risk is of particular concern when facilities rear listed species, but must be addressed to ensure meeting program goals and objectives. Factors such as flow reductions, flooding and poor fish culture practices may all cause hatchery facility failure or the catastrophic loss of fish under propagation. The following measures are considered important in reducing the risk of catastrophic loss resulting from the use of temporary ponds or net pens in the White River basin:

- Installing back-up generators where power is necessary to provide water to vessels.
- Training all hatchery personnel in standard fish propagation and fish health maintenance methods.
- Using low pressure/low water level alarms for water supplies to notify personnel of water emergencies.
- Provide on-site or local residence for hatchery personnel to allow rapid response to power or facility failures.

Any temporary acclimation facilities would consider, and apply as appropriate, the above measures to reduce the risks associated with hatchery facility failures.

<u>Hatchery Water Intake Impacts:</u> Water withdrawals for the temporary rearing ponds within spawning and rearing areas could diminish stream flow, impeding migration and affect the spawning behavior of listed fish. Water withdrawals could also affect other stream-dwelling organisms that serve as food for juvenile salmonids by reducing habitat and through displacement, and physical injury. The temporary rearing pond intake would be screened to prevent fish injury from impingement or permanent removal from the White River. Any temporary rearing pond would be designed to be non-consumptive. That is, water used in the facility would be returned near the point where it was withdrawn to minimize effects on naturally

produced fish and other aquatic fauna. In general, the risks associated with water withdrawals would be minimized by complying with water right permits and meeting NMFS screening criteria (NMFS 1995b; NMFS 1996a; NMFS 2004c). These screening criteria for water withdrawal devices set forth conservative standards that help minimize the risk of harming naturally produced salmonids and other aquatic fauna.

Hatchery Effluent Discharge Impacts: Effluent discharges could change water temperature, pH, suspended solids, ammonia, organic nitrogen, total phosphorus, and chemical oxygen demand in the receiving stream's mixing zone (Kendra 1991). The level of impact would depend on the amount of discharge and the flow volume of the receiving stream. Only about 2 percent of the White River would be diverted into temporary rearing ponds. This water would be returned near the removal location. Any adverse impacts would probably occur at the immediate point of discharge, because effluent dilutes rapidly. The Clean Water Act requires hatcheries (i.e. "aquatic animal production facilities") with annual production greater than 20,000 lbs to obtain a National Pollutant Discharge Elimination System (NPDES) permit in order to discharge hatchery effluent to surface waters. The proposed program would produce only about 10,000 pound of salmon (150,000 smolts at 15 fish per pound). These permits are intended to protect aquatic life and public health and ensure that every facility treats its wastewater. The impacts from the releases are analyzed and the permit sets site-specific discharge limits and monitoring and reporting requirements for the permits and is subject to enforcement actions (EPA 1999). In addition, hatcheries in the Columbia River Basin, including this program in the White River, would operate under the policies and guidelines developed by the Integrated Hatchery Operations Team (IHOT 1995) to reduce hatchery impacts on listed fish. Impacts on both listed UCR salmon and UCR steelhead in the White River are effectively minimized by having the program facilities maintain NPDES permits for discharge of hatchery effluent, and by meeting IHOT guidelines.

In summary, risks to listed fish from the operation of hatchery facilities would be minimized by applying measures as proposed in the permit application and as specified in permit terms and conditions such as back-up power sources or alarms, securing appropriate permits and policies that were designed to reduce adverse impacts on listed UCR salmon and UCR steelhead.

4.2.2 Broodstock Collection

Broodstock collection can affect listed salmonids through the method of collection and by the removal of individuals from the population. Most artificial propagation programs collect adult fish to use as broodstock. The proposed program would collect eggs or fry from the White River spring Chinook salmon to rear in captivity until the adult stage to use as broodstock. Listed UCR steelhead adults are not present at the time of year when broodstock collection activities occur. The abundance of juvenile steelhead in the White River would be very low based on the number of steelhead redds found in the White River in recent years (see Table 4). Therefore, no impacts on UCR steelhead would be expected during broodstock collection activities.

The goal of the proposed program is to collect about 1,500 eggs by injecting a water and air mixture into the redd that causes eggs in the gravel to float to the surface into a collection net (Young and Marlowe 1995; Shaklee et al. 1995; WDFW et al. 1995; WDFW 1998). The number of eggs removed from each redd would depend on the number of redds available for egg collection, but would not exceed 150 eggs from any single redd and no more than 50 redds would be impacted in one year (Table 5). The estimated number of eggs in each spring Chinook salmon redd in the White River is 4,200 (range 3,900-4,500) based on egg counts of hatchery spawned fish from the Chiwawa spring Chinook salmon program. The permit applicants assumed the mortality rate of eggs remaining in the gravel would be less than 2 percent of the number of eggs removed. Empirical data specific to mortality impacts from egg extraction activities is not available. Gathering such information at an acceptable level of confidence is not practical because a very large number of redds would need to be monitored and the methods to count eggs in a redd could result in very high mortality of the eggs which would be counterproductive to conservation efforts.

In order to estimate the numeric impact of the egg collection, NMFS assumes the maximum number of eggs to be collected from a single redd would be 150, although in most cases the actual egg collected would be less because the permit holders would attempt to collect eggs from as many redds as possible. Under the worst case scenario, if 150 eggs are collected from each redd, the mortality of eggs left in the redd would be estimated at 3 eggs and the total impact to a single redd would be about 3.6 percent (Table 5). A similarly implemented program has not detected a reduction in natural production in areas where eggs or fry are collected using this technique (Young and Marlowe 1995).

Table 5. Estimated impact of collecting eggs from redds in the White River.

Redds Sampled	Eggs Collected	Eggs Killed	Total Impact [1]	
10	150	3	153	3.6%
15	100	2	102	2.4%
20	75	2	77	1.8%
25	60	1	61	1.5%
30	50	1	51	1.2%
35	43	1	44	1.0%
40	38	1	38	0.9%
45	33	1	34	0.8%
50	30	1	31	0.7%

[1] *Assumed 4,200 eggs per redd and 2 percent of eggs remaining in a redd would be killed as a result of egg collection activities.*

In years in which eyed eggs could not collected for broodstock, the proposed program would collect up to 100 emergence fry from up to 50 natural deposited redds or in close proximity of redds in the White River to obtain a total of 1,270 fry by either fry trapping individual redds (Frayley et al 1986; Murdoch et al. 2005) or seining in close proximity to redds. The permit applicants assumed the mortality rate of eggs/alevin remaining in the gravel would be less than 2 percent of the number of fry captured. The applicants propose to closely monitor embryo development such that fry traps would be installed to coincide with emergence and only be required for a short duration. Fry traps would be of sufficient size that the redd would not be impacted. Fry collected in excess of program needs would be released immediately in the vicinity of the redd. Empirical data specific to mortality impacts from fry trapping is not available. Gathering such information at an acceptable level of confidence is not practical because a very large number of redds would need to be monitored and could result in very high mortality of the eggs or fry which would be counterproductive to conservation efforts. As stated above, the estimated number of eggs in each spring Chinook salmon redd in the White River is 4,200 (range 3,900-4,500). In order to estimate the numeric impact of the fry collection, NMFS assumes the maximum number of fry to be collected from a single redd would be 100, although in most cases the actual number collected would be less because the permit holders would attempt to collect fry from as many redds as possible. Under the worst case scenario, if 100 fry are collected from each redd, the mortality of eggs left in the redd would be zero and fry mortality in the trap collection bottle, estimated at 2 percent (A. Murdoch, March 19, 2007, pers. com.) which would result in 2 fry out of 100 being killed (Table 6). Fraley et al. (1986) reported fry mortality in an emergence trap as almost nil if the trap was checked at least once a week. The permit applicants proposed checking fry traps on a daily basis to minimize mortality.

Table 6. Estimated impact of collecting fry from redds in the White River.

Redds Sampled	Fry Collected	Fry Killed	Total Impact [1]	
10	100	2	102	2.4%
15	85	2	86	2.1%
20	64	1	65	1.5%
25	51	1	52	1.2%
30	42	1	43	1.0%
35	36	1	37	0.9%
40	32	1	32	0.8%
45	28	1	29	0.7%
50	25	1	26	0.6%

[1] *Assumed 4,200 eggs per redd and 2 percent of fry captured in an emergent trap would be killed as a result of the trap.*

In order to evaluate the potential impacts of egg or fry collection on the long-term survival of the population, NMFS converted the egg or fry impacts to adult salmon. This also allows for the comparison of this strategy for collecting broodstock to the traditional adult salmon broodstock collection programs. Because little empirical data exists about spring Chinook in the White River, NMFS relied on empirical data from the Chiwawa River. Egg-to-emigrant survival for spring Chinook salmon in the Chiwawa River ranges between 4.6 to 18.1 percent and the average emigrant-to-adult survival is 0.97 percent. Assuming spring Chinook in the White River achieve an egg-to-emigrant survival that is not less than the maximum reported for Chiwawa spring Chinook salmon, the mortality associated with egg or fry collections would be the equivalent of 18-51 emigrant fish. Assuming that spring Chinook salmon from the White River achieve a similar emigrant-to-adult survival as Chiwawa River spring Chinook salmon (0.97 percent), the net impact on adult salmon returning to the White River would be less than one adult salmon.

The more common method of collecting broodstock for a hatchery program is to collect adult salmon that returning to spawn. This standard broodstock collection strategy uses a weir, or a fish ladder-trap combination associated with a barrier, such as a dam. These devices are employed to effectively block upstream migration and force returning adult fish to enter a trap and holding area. Trapped fish are counted and either retained for use in the hatchery or released to spawn naturally. The physical presence and the operation of a weir or trap can affect salmonids. Detailed discussions of potential impacts from adult broodstock collection have been detailed in other documents (NMFS 2002a, b, and c).

The removal of adults from a naturally-spawning population has the potential to reduce the size of the natural population (sometimes called “mining”), cause selection effects, and remove nutrients from upstream reaches (Spence et al. 1996; NRC 1996; Kapusinski 1997). In cases where listed salmonid populations are not even replacing themselves and a supplementation hatchery program can slow trends toward extinction and buy time until the factors limiting population viability are corrected, risks to the natural population, including numerical reduction and selection effects, are in some cases subordinate to the need to expeditiously implement the artificial production programs that will reduce the likelihood of extinction in the short term of the populations and potentially the ESU (i.e., Redfish Lake sockeye, UCR spring Chinook salmon).

To achieve a smolt production target of 150,000 spring Chinook salmon smolts about 89 adults would have to be collected from the White River (Table 7). Considering the low number of adults returning to the White River in recent years, the egg or fry collection that would result in an adult abundance reduction of 1 salmon.

Table 7. Estimated broodstock needed to meet 150,000 smolt production target in an adult-based broodstock strategy.

Program Assumptions	Standard	Program
Smolt release target		150,000
Fertilization-to-release survival	83%	
Eggtake target		180,723
Fecundity	4,200	
Female target		43
Female to male ratio	1 to 1	
Broodstock target		86
Pre-spawn survival	97%	
Total broodstock needed		**89**

NMFS concludes that the impact on UCR spring Chinook salmon from the proposed egg or fry collection based on the above analysis equates to the loss of 1 adult spring Chinook salmon. The loss of 1 adult salmon is not likely to appreciably reduce the likelihood of continued existence or recovery of the species.

4.2.3 Genetic Risks

A defining characteristic of anadromous salmonids is their high fidelity to their natal streams. Their ability to home with great accuracy and maintain high fidelity to natal streams has encouraged the development of locally adapted genetic characteristics that allow the fish to use specific habitats. The genetic risks that artificial propagation poses to naturally produced populations can be separated into reductions or changes in the genetic variability (diversity) among populations and changes within populations (Hard et al. 1992; Cuenco et al. 1993; NRC 1996; Waples 1996).

<u>Loss of Diversity Among Populations:</u> Genetic differences among salmon populations arise as a natural consequence of their homing tendency. Homing leads to a relatively high degree of demographic isolation among populations. This demographic isolation produces conditions where evolutionary forces such as natural selection and random genetic drift create differences in allele frequencies among populations. Many of these differences are believed to be adaptive – meaning that populations have been shaped by natural selection to have a particularly good fit to their local environment (see Taylor 1991, and McElhany et al. 2000 for reviews).

Excessive gene flow into a natural population from naturally spawning hatchery fish can reduce the fitness of individual populations through a process called outbreeding depression. Outbreeding depression arises because natural salmonid populations adapt to the local environment and this adaptation is reflected in the frequency of specific alleles that improve survival in that environment. When excessive gene flow occurs, alleles that may have developed in a different environment are introduced and these new alleles may not benefit the survival of the receiving population leading to outbreeding depression.

Another source of outbreeding depression is the loss of combinations of alleles called coadapted complexes. Gene flow can introduce new alleles that can replace alleles in the coadaptive complexes leading to a reduction in performance (Busack and Currens 1995). Outbreeding depression from gene flow can occur when eggs and fish are transferred among populations and/or when out of basin hatchery populations are released to spawn with the local population.

There is evidence for local adaptation of salmonid populations (see Taylor 1991, and McElhany et al. 2000 for reviews), but the only empirical data on outbreeding depression in fish involves distantly related populations (Busack and Currens 1995). Pacific Northwest hatchery programs historically contributed to the loss of genetic diversity among populations through the routine transfer of eggs and fish from different hatchery populations. Such practices are no longer routine and in fact are being restricted through management policy. The release or straying of hatchery fish into non-target populations has also resulted in gene flow above natural levels (genetic introgression), reducing the genetic diversity among populations. Research based primarily on findings in the Kalama River, Washington, for summer-run steelhead has suggested that interbreeding between non-indigenous Skamania hatchery stock steelhead (a highly domesticated, hatchery stock) and native naturally produced fish may have negatively affected the genetic diversity and long term reproductive success of naturally produced steelhead (Leider et al. 1990; Hulett et al. 1996). Non-indigenous hatchery and native naturally produced steelhead crosses may be less effective at producing adult off-spring in the natural environment compared to naturally produced fish (Chilcote et al. 1986; 1998; Bluoin 2004).

Campton (1995) examined the risks of genetic introgression to naturally produced fish and suggested the need to distinguish the biological effects of hatcheries and hatchery fish from the indirect and biologically independent effects of fisheries management actions. In his review of the scientific literature for steelhead, he suggested that many of the genetic effects detected to date appear to be caused by fisheries management practices such as stock transfers and mixed stock fisheries and not by biological factors intrinsic to hatchery fish (Campton 1995). However, loss of among population genetic diversity as a result of these types of hatchery practices has been documented for western trout, where unique populations have been lost through hybridization with introduced rainbow trout (Behnke 1992). Phelps et al. (1994) found evidence for introgression of non-native hatchery steelhead into a number of natural populations within the southwest Washington region. However, in other areas where hatchery production has been extensive, native steelhead genotypes have been shown to persist (Phelps et al. 1994; Narum et al. 2006).

The loss of genetic variability among populations can be minimized by:

- Propagating and releasing only fish from the local indigenous population or spawning aggregate.
- Avoiding or adequately reducing, gene-flow from a hatchery program into a natural population.
- Limiting the transfers of fish between different areas.
- Acclimate hatchery fish in the target watershed to ensure that the hatchery fish retain a high fidelity to the targeted stream.
- Using returning spawners rather than the transferred donor population as broodstock for restoration programs to foster local adaptation.
- Maintaining natural populations that represent sufficient proportions of the existing total abundance and diversity of an ESU/DPS without hatchery intervention.
- Visually marking all hatchery-produced salmonids to allow for monitoring and evaluation of straying and contribution to natural production (Kapuscinski and Miller 1993; Flagg and Nash 1999).

The proposed propagation program specifically targets enhancing the locally adapted spawning aggregate in the White River to minimize the loss of diversity within a population and as such would function to increase diversity among populations. The proposed program would propagate and release fish into the same area from which their parents were collected. The program is sized to adequately manage the gene flow between natural and hatchery reared fish. No transfers of fish from or into the White River that are not White River lineage fish would occur. The propagated fish would be acclimated to the White River to ensure fidelity to the area. All fish released would be marked or tagged for identification purposes.

<u>Loss of Diversity Within Populations:</u> Loss of within population genetic diversity due to artificial propagation is caused by genetic drift, inbreeding depression, and/or domestication selection.

Loss of within population genetic diversity (variability) is defined as the reduction in quantity, variety and combinations of alleles in a population (Busack and Currens 1995). Quantity is defined as the proportion of an allele in the population and variety is the number of different kinds of alleles in the population.

<u>Genetic Drift:</u> Genetic diversity within a population can change from random genetic drift and from inbreeding. Random genetic drift occurs because the progeny of one generation represents a sample of the quantity and variety of alleles in the parent population. Since the next generation is not an exact copy of the parent generation, rare alleles can be lost, especially in small populations where a rare allele is less likely to be represented in the next generation (Busack and Currens 1995).

The process of genetic drift is governed by the effective population size rather than the observed number of breeders. The effective size of a population is defined as the size of an idealized population that would produce the same level of inbreeding or genetic drift seen in an observed population of interest (see Hartl and Clark 1989). Attributes of such an idealized population typically include discrete generations, equal sex ratios, random mating and specific assumptions about the variance of family size. Real populations almost always violate one or more of these idealized attributes, and the effective size of a population is therefore almost always smaller than the observed census size. Small effective population size in hatchery programs can be caused by:

- Using a small number of adults for hatchery broodstock.
- Using more females than males (or males than females) for the hatchery broodstock.
- Pooling the gametes of many adults during spawning which would allow one male to potentially dominate during fertilization.
- Changing the age structure of the spawning population from what would have occurred naturally.
- Allowing progeny of some matings to have greater survival than allowed others (Gharrett and Shirley 1985; Simon et al. 1986; Withler 1988 cited in Busack and Currens 1995; Waples 1991; Campton 1995).

Some hatchery stocks have been found to have less genetic diversity and higher rates of genetic drift than some naturally produced populations, presumably as a result of a small effective number of breeders in the hatcheries. Potential, negative impacts of artificial propagation on within population diversity may be indicated by changes in morphology (e.g., Bugert et al. 1992) or behavior of salmonids (e.g. Berejikian 1995). Busack and Currens (1995) observed that it would be difficult to totally control random loss of within population genetic diversity in hatchery populations, but by controlling the broodstock number, sex ratios, and age structure, loss could be minimized. Theoretical work has demonstrated that hatcheries can reduce the effective size of a natural population in cases where a large number of hatchery strays are produced by a relatively small number of hatchery breeders (Ryman et al. 1995). This risk can be minimized by having hatcheries with large effective population sizes and by controlling the rate of straying of hatchery fish into naturally produced populations.

Inbreeding Depression: The breeding of related individuals (inbreeding) can change the genetic diversity within a population. Inbreeding per se does not lead directly to changes in the quantity and variety of alleles but can increase both individual and population homozygosity. This homozygosity can change the frequency of phenotypes in the population which are then acted upon by the environment. If the environment is selective towards specific phenotypes then the frequency of alleles in the population can change (Busack and Currens 1995). Increased homozygosity is also often expected to lead to a reduction in fitness called inbreeding depression. Inbreeding depression occurs primarily because nearly all individuals harbor large numbers of deleterious alleles whose effects are masked because they also carry a non-deleterious ‘wild type’ allele for the same gene. The increased homozygosity caused by inbreeding leads to a higher frequency of individuals homozygous for deleterious alleles, and thus a reduction in the mean fitness of the population (see Waldman and McKinnon 1993 for a review).

It is important to note that there is little empirical data on inbreeding depression or substantial loss of genetic variability in any natural or hatchery population of Pacific salmon or steelhead, although there are considerable data on the effects of inbreeding in rainbow trout (Hard and Hershberger 1995, quoted in Myers et al. 1998). Studying inbreeding depression is particularly difficult in anadromous Pacific salmon because of their relatively long generation times, and the logistical complexities of rearing and keeping track of large numbers of families. Monitoring the rate of loss of molecular genetic variation in hatchery and naturally produced populations is one alternative method for studying the impacts of hatcheries on genetic variability (e.g., Waples et al. 1993), but does not provide information on inbreeding depression or other fitness effects associated with changes in genetic variation. Many of these changes are also expected to occur over many generations; long term monitoring is likely to be necessary to observe all but the most obvious changes.

The impacts of inbreeding between hatchery and natural stocks can be minimized following an isolated hatchery strategy by:

- Releasing fewer or no hatchery fish into the natural population.
- Releasing hatchery fish only at the hatchery or at locations where they are unlikely to interbreed with natural fish when returning as adults.
- Advancing or retarding the time of spawning for hatchery fish, to minimize the overlap in spawning time between hatchery and natural fish.
- Acclimating hatchery fish prior to release to improve homing precision.
- Acclimating and releasing hatchery fish at locations where returning adults can be harvested at high rates (harvest augmentation programs), locations away from natural production areas and sites where returning adults can be sorted and removed from the spawning population.

<u>Domestication Selection:</u> Domestication means changes in quantity, variety and combination of alleles between a hatchery population and its source population that are the result of selection in the hatchery environment (Busack and Currens 1995). Domestication is also defined as the selection for traits that favor survival in a hatchery environment and that reduce survival in natural environments (NMFS 1999c). Domestication can result from rearing fish in an artificial environment that imposes different selection pressures than what they would encounter in the wild. The concern is that domestication effects will decrease the performance of hatchery fish and their descendants in the wild. Busack and Currens (1995) identified three types of domestication selection (1) intentional or artificial selection, (2) biased sampling during some stage of culture, and (3) unintentional or relaxed selection.

(1) Intentional or artificial selection is the attempt to change the population to meet management needs, such as time of return or spawning time. Hatchery fish selected to perform well in a hatchery environment tend not to perform well when released into the wild, due to differences between the hatchery and the naturally produced populations resulting from the artificial propagation. Natural populations can be impacted when hatchery adults spawn with

natural-origin fish and the performance of the natural population is reduced (a form of outbreeding depression) (Busack and Currens 1995).

(2) Biased sampling leading to domestication can be caused by errors during any stage of hatchery operation. Broodstock selection is a common source of biased sampling when adults are selected based on particular traits. Hatchery operations can be a source of biased sampling when groups of fish are selected against when feeding, ponding, sorting and during disease treatments because different groups of fish will respond differently to these activities.

(3) Genetic changes due to unintentional or relaxed selection occur because salmon in hatcheries usually have (by design) much higher survival rates than they would have in the wild. Hatchery fish are reared in a sheltered environment that increases their survival relative to similar life stages in the natural environment allowing deleterious genotypes that would have been lost in the natural environment to potentially contribute to the next generation.

Reisenbichler and Rubin (1999) cite five studies indicating that hatchery programs for steelhead and stream-type Chinook salmon (i.e., programs holding fish in the hatchery for one year or longer) genetically change the population and thereby reduce survival for natural rearing. The authors report that substantial genetic change in fitness can result from traditional artificial propagation of salmonids held in captivity for one quarter or more of their life. Bugert et al. (1992) documented morphological and behavioral changes in returning adult hatchery spring Chinook salmon relative to natural adults, including younger age, smaller size, and reduced fecundity. However, since that study, differences in size and age at return have been found to be more related to smolt size at release than domestication selection. Differences in fecundity are still observed, but not fully understood.

Leider et al. (1990) reported diminished survival and natural reproductive success for the progeny of non-native hatchery steelhead when compared to native naturally produced steelhead in the lower Columbia River region. The poorer survival observed for the naturally produced offspring of hatchery fish could have been due to the long term artificial and domestication selection in the hatchery steelhead population, as well as maladaptation of the non-indigenous hatchery stock in the recipient stream (Leider et al. 1990). Ongoing research on winter steelhead in the Hood River basin (Blouin 2004) compared the reproductive success of hatchery and natural-origin adults. The old program, that used out-of-basin broodstock, was determined to be 17 to 54 percent as reproductively successful (i.e., life cycle survival) as the natural-origin adults. Hatchery origin fish were determined to be 85 to 108 percent as successful as natural-origin adults when the broodstock was comprised exclusively of natural origin fish from the Hood River. These results do not support the assumption of domestication selection in first generation of hatchery rearing for steelhead.

Berejikian (1995) reported that wild-origin steelhead fry survived predation by prickly sculpins (*Cottus asper*) to a statistically significant degree better than size-matched off-spring of locally-derived hatchery steelhead that were reared under similar conditions. Alteration of the innate predator avoidance ability through domestication was suggested by the results of this study. However, Joyce et al. (1998) reported that an Alaskan spring Chinook salmon stock under domestication for four generations did not significantly differ from offspring of naturally produced spawners in their ability to avoid predation. The domesticated and naturally produced Chinook salmon groups tested also showed similar growth and survival rates in freshwater performance trials.

Domestication effects from artificial propagation and the level of genetic differences between hatchery and natural fish can be minimized by:

- Randomly selecting adults for broodstock from throughout the natural population migration to provide an unbiased sample of the natural population with respect to run timing, size, age, sex ratio, and other traits identified as important for long term fitness.
- Ensuring that returning adults used as broodstock by a hatchery continually incorporate natural-origin fish over the duration of the program to reduce the likelihood for divergence of the hatchery population from the natural population.
- Employing appropriate spawning protocols to avoid problems with inbreeding, genetic drift and selective breeding in the hatchery (e.g., Simon et al. 1986; Allendorf and Ryman 1987; Gall 1993). Methods include collection of broodstock proportionally across the breadth of the natural return, randomizing matings with respect to size and phenotypic traits, application of at least 1:1 male to female mating schemes (Kapuscinski and Miller 1993), and avoidance of intentional selection for any life history or morphological trait.
- Using spawning protocols that equalize as much as possible the contributions of all parents to the next breeding generation.
- Using only natural fish for broodstock in the hatchery each year to reduce the level of domestication.
- Setting minimum broodstock collection objectives to allow for the spawning of the number of adults needed to minimize the loss of some alleles and the fixation of others (Kapuscinski and Miller 1993).
- Setting minimum escapements for natural spawners and maximum broodstock collection levels to allow for at least 50 percent of escaping fish to spawn naturally each year, to help maintain the genetic diversity of the donor natural population.
- Using hatchery methods that mimic the natural environment to the extent feasible (e.g. use of substrate during incubation, exposure to ambient river water temperature regimes and structure in the rearing ponds).

NMFS believes that the measures identified for minimizing the potential adverse genetic impacts of hatchery produced fish on naturally produced fish should be applied to protect listed species. The actual measures selected will depend on a number of factors including but not limited to:

- The objectives of the program (i.e. recovery, reintroduction or harvest augmentation).
- The source of the broodstock, its history and level of domestication.
- The spawning protocols proposed for the hatchery program.
- The status of the natural population targeted by the hatchery program.
- The ability of fish managers to remove or control the number of hatchery adults in the natural spawning population.
- The proposed rearing practices for the hatchery program.

- The total number of hatchery fish released into the subbasin.

More detailed discussions on the measures to implement these strategies can be found in Reisenbichler (1997), Reisenbichler and McIntyre (1986), Nelson and Soule (1987), Goodman (1990), Hindar et al. (1991), and Waples (1991) among others.

All of the actions listed above that serve to reduce the loss of diversity among populations apply to the proposed propagation program. The egg and fry collection strategy is designed to allow natural processes such as mate selection to create the foundation for the program and would reduce the potential for domestication. The collection of eggs or fry from as many redds/families as possible to reduce the risks loss of within population diversity. The mating scheme of the broodstock also maximizes the number of contributing parents by using a 2 by 2 factorial scheme. In other words, the eggs from one female are spilt into two lots and each lot is fertilized with a different male. Additionally, crosses among broodstock from different brood years would be done to minimize the risks.

The release of fry would occur in years when eggtake from captive adults exceeds the number needed to achieve the 150,000 yearling smolt target. This release strategy would serve to maintain the yearling release number at an appropriate level and reduce the potential genetic impacts associated with longer term hatchery rearing for a portion of the program by allowing fish released as fry to experience the natural selection pressures in their native habitats.

The program release target is set at a level that should boost the number of spring Chinook salmon spawning in the area, but not overwhelm or swamp the natural-origin fish or exceed the estimated available habitat in the White River basin. All fish released will be marked or tagged to allow their identification as adults. NMFS believes that based on the preceding discussion and by following the above practices, the genetic risks to the natural populations are sufficiently minimized and that the program should enhance the natural population.

4.2.4 Disease

Hatchery effluent has the potential to transport fish pathogens out of the hatchery, where natural fish may be exposed to infection. Interactions between hatchery fish and natural fish in the environment may also result in the transmission of pathogens, if either the hatchery or natural fish are harboring fish disease. This latter impact may occur in tributary areas where hatchery fish are released and throughout the migration corridor where hatchery and naturally produced fish may interact. As the pathogens responsible for fish diseases are present in both hatchery and natural populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976; Hastein and Lindstad 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress and can lead to greater manifestation and spread of disease within the hatchery population. Under natural, low density conditions, most pathogens do not lead to a disease outbreak. When fish disease outbreaks do occur, they are often triggered by stressful hatchery rearing conditions, or by a deleterious change in the environment (Saunders 1991). Consequently, it is possible that the release of hatchery fish may lead to the loss of natural fish, if the hatchery fish are carrying a pathogen not carried by the natural fish, if that pathogen is transferred to the natural fish, and if the transfer of the pathogen leads to a disease outbreak.

Recent studies suggest that the incidence of some pathogens in naturally spawning populations may be higher than in hatchery populations (Elliott and Pascho 1994). The incidence of high ELISA titers for *Renibacterium salmoninarum*, the causative agent of Bacterial Kidney Disease (BKD), appears, in general, to be more prevalent to a statistically significant degree among wild smolts of spring/summer Chinook salmon than hatchery smolts (Congleton et al. 1995; Elliot et al. 1997). For example, 95 percent and 68 percent of wild and hatchery smolts, respectively, at Lower Granite Dam in 1995 had detectable levels of *R. salmoninarum* (Congleton et al. 1995). Although pathogens may cause a high rate of post-release mortality among hatchery fish, there is little evidence that hatchery-origin fish routinely infect naturally produced salmon and steelhead in the Pacific Northwest (Enhancement Planning Team 1986; Steward and Bjornn 1990).

Many of the disease concerns related to hatchery fish are based on old management styles that emphasized the release of large numbers of fish regardless of their health status. Since that time, the desire to reduce disease has instigated better husbandry, including critical decreases in fish numbers to reduce crowding and stress that affects the resistance of salmonids to disease (Salonius and Iwama 1993; Schreck et al. 1993). Along with decreased densities and improved animal husbandry, advances in fish health care and adherence to federal and interagency fish health policies have considerably decreased the possibility of disease transmission from hatchery fish to natural-origin fish.

State and federal fisheries agencies have established Fish Pathology labs and personnel who monitor and manage fish health in state, federal and tribal hatcheries. The success of hatchery programs as reflected in the production of quality smolts that will survive and reproduce depend on good fish health management. Fisheries managers, to meet hatchery fish quality goals and to address concerns of potential disease transmission from hatchery salmonids to naturally produced fish, have established a number of fish health policies in the Pacific Northwest Region. These policies established guidelines to ensure that fish health is monitored, sanitation practices are applied, and that hatchery fish are reared and released in healthy condition (PNFHPC 1989; IHOT 1995; WDFW 1996; WDFW and WTIT 1998; USFWS 1995). Standard fish health monitoring under these policies include monthly and pre-release checks of propagated salmonid populations by a fish health specialist, with intensified efforts to monitor presence of specific pathogens that are known to occur in the populations. Specific reactive and proactive strategies for disease control and prevention are also included in the fish health policies. Fish mortality at the hatchery due to unknown cause(s) will trigger sampling for histopathological study. Incidences of viral pathogens in salmonid broodstocks are determined by sampling fish at spawning. Populations of particular concern may be sampled at the 100 percent level and may require segregation of eggs/progeny in early incubation or rearing. In some programs, progeny of high titer adults are culled to minimize disease incidence within the hatchery populations. Compliance with NPDES permit provisions at hatcheries also acts to minimize the likelihood for disease epizootics and water quality impacts that may lead to increased naturally produced fish susceptibility to disease outbreaks. Full compliance with the regional fish health policies minimizes the risk for fish disease transfer.

The proposed program would follow current fish health policies and recommendations. Regular fish health examinations would be done by qualified staff. Compliance with any NPDES permit and standard fish health protocols would be required in the terms and conditions of ESA permit 1592. Because this program propagated endangered fish, it is unlikely that eggs or fish would be culled as a disease management strategy. If portions of the program are found to pose an increased disease risk to either other fish in the program or the natural populations, then the PRCC HSC would request guidance from fish health experts on how to manage that risk on a case by case basis. NMFS believes that these steps adequately minimize the risk to listed species.

4.2.5 Competition/Density Dependent Effects

Competition occurs when the demand for a resource by two or more organisms exceeds the available supply. If the resource in question (e.g., food or space) is present in such abundance that it is not limiting, then competition is not occurring, even if both species are using the same resource. Adverse impacts of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility to limited resources by naturally produced fish, or through indirect means, as in when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with adverse competitive impacts of hatchery salmonids on listed naturally produced salmonids may include food resource competition, competition for spawning sites, and redd superimposition. In an assessment of the potential ecological impacts of hatchery fish production on naturally produced salmonids, the Species Interaction Work Group (SIWG 1984) categorized species combinations as to whether there is a high, low, or unknown risk that competition by hatchery fish will have a negative impact on productivity of naturally produced salmonids in freshwater areas (Table 9).

Table 8. Risk of hatchery salmonid species competition on naturally produced salmonid species in freshwater areas (SIWG 1984).

Hatchery Species	Naturally produced Species					
	Steelhead	Pink Salmon	Chum Salmon	Sockeye Salmon	Coho Salmon	Chinook Salmon
Steelhead	H	L	L	L	H	H
Pink Salmon	L	L	L	L	L	L
Chum Salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	H	L	L	L	H	H
Chinook Salmon	H	L	L	L	H	H

Note: “H” = High risk; “L” = Low risk; and “U” = Unknown risk of a significant impact occurring.

Density-dependent effects result from compensation (a decrease in productivity with increasing density) and depensation (an increase in productivity with increasing density). Understanding the mechanisms that may lead to depensatory processes is important (Hunter et al. 2005). However, identifying the depensatory mechanisms does not necessarily imply the dynamics of a population are depensatory. Often there is little evidence that any depensation is strong enough to be important in a population's dynamics (Liermann & Hilborn 2001). Detecting populations with depensatory dynamics is difficult because other non-depensatory factors (e.g., temperature, depth, and predator numbers) may act on the population processes and possibly prevent the depensatory mechanism coming into play. Contributing to the difficultly is the constraint that the species has to be at a low abundance level. Understanding the recovery dynamics of the species may be one way of establishing the importance of depensation to the population (Hunter et al. 2005).

<u>Adult fish:</u> It is apparent that salmonids have evolved a variety of strategies to partition available resources between species that are indigenous to a particular watershed. The addition of homing or straying adult hatchery-origin fish can perturb these mechanisms and impact the productivity of naturally produced stocks. For adult salmonids, impacts from hatchery/naturally produced fish competition in freshwater are assumed to be greatest in the spawning areas where competition for redd sites and redd superimposition may be concerns. Adult salmonids originating from hatcheries can also compete with naturally produced fish of the same species for mates, leading to an increased potential for outbreeding depression. Hatchery-origin adult salmonids may home to, or stray into, natural production areas during naturally produced fish spawning or egg incubation periods, posing an elevated competitive and behavioral modification risk. Returning or straying hatchery fish may compete for spawning gravel, displace naturally produced spawners from preferred, advantageous spawning areas, or adversely affect listed salmonid survival through redd superimposition. Superimposition of redds by similar-timed or later spawners, disturbs or removes previously deposited eggs from the gravel, and has been identified as an important source of natural salmon mortality in some areas (Bakkala 1970).

Recent studies suggest that hatchery-origin fish may be less effective in competing for spawning sites than naturally produced fish of the same species, possibly indicating the effects of domestication selection in the hatchery environment (Fleming and Gross 1993; Berejikian et al. 1997). These studies were based on comparisons of natural-origin salmonid adults and captive-brood origin hatchery fish. Hatchery-origin salmonid adults returning to spawn after a period of rearing in the wild may exhibit different competitive effectiveness levels.

The risk of straying by hatchery-produced species may be minimized through acclimation of the fish to their stream of origin, or desired stream of return. Homing fidelity may be improved through the use of locally adapted stocks, and by rearing of the fish for an extended duration (e.g., eyed egg to smolt) in the "home" stream prior to release or transfer to a marine area net-pen site for further rearing.

The risk of redd superimposition can be minimized through high removal rates of the hatchery-origin fish, and by propagation and release of only indigenous species and stocks. Indigenous-origin hatchery adults that are not removed upon return may be assumed to still carry traits that foster temporal and spatial resource partitioning with wild-spawning fish populations (see SIWG

1984). The risk of redd disturbance may therefore be minimal with escapement of indigenous-origin hatchery fish, if the home stream has the physical characteristics (e.g., stream flow, usable channel width) that will allow such partitioning at the time of spawning.

Juvenile fish: For salmonids rearing in freshwater, food and space are the resources in demand, and thus are the focus of inter- and intra-specific competition (SIWG 1984). Newly released hatchery smolts potentially compete with naturally produced fish for food and space in areas where they interact during downstream migration. Naturally produced fish may be competitively displaced by hatchery fish early in life, especially when hatchery fish are more numerous, of equal or greater size, and (if hatchery fish are released as non-migrants) the hatchery fish have taken up residency before naturally produced fry emerge from redds. Release of large numbers of hatchery pre-smolts in a small area is believed to have greater potential for competitive impacts because of the extended period of interaction between hatchery fish and natural fish. In particular, hatchery programs directed at fry and non-migrant fingerling releases will produce fish that compete for food and space with naturally produced salmonids for longer durations, if the hatchery fish are planted within, or disperse into, areas where naturally produced fish are present. A negative change in growth and condition of naturally produced fish through a change in their diet or feeding habits could occur following the release of hatchery salmonids. Any competitive impacts likely diminish as hatchery-produced fish disperse, but resource competition may continue to occur at some unknown, but lower level as natural-origin juvenile salmon and any commingled hatchery juveniles emigrate seaward.

Hatchery fish might alter naturally produced salmon behavioral patterns and habitat use, making them more susceptible to predators (Hillman and Mullan 1989; Steward and Bjornn 1990). Hatchery-origin fish may also alter naturally produced salmonid migratory responses or movement patterns, leading to a decrease in foraging success (Steward and Bjornn 1990; Hillman and Mullan 1989). In a review of the potential adverse impacts of hatchery releases on naturally produced salmonids, Steward and Bjornn (1990) indicated that it was indeterminate from the literature whether naturally produced parr face statistically significant risk of displacement by introduced hatchery fish, as a wide range of outcomes from hatchery-naturally produced fish interactions has been reported. The potential for negative impacts on the behavior, and hence survival, of naturally produced fish as a result of hatchery fish releases depends on the degree of spatial and temporal overlap in the occurrence of hatchery and naturally produced fish. The relative size of affected naturally produced fish when compared to hatchery fish, as well as the abundance of hatchery fish encountered, also will determine the degree to which naturally produced fish are displaced (Steward and Bjornn 1990). Actual impacts on naturally produced fish would thus depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990).

En masse hatchery salmon smolt releases may cause displacement of rearing naturally produced juvenile salmonids from occupied stream areas, leading to abandonment of advantageous feeding stations, or premature out-migration (Pearsons et al. 1994). Pearsons et al. (1994) reported displacement of juvenile naturally produced rainbow trout from discrete sections of streams by hatchery steelhead released into an upper Yakima River tributary, but no large scale displacements of trout were detected. Small scale displacements and agonistic interactions that were observed between hatchery steelhead and naturally produced trout resulted from the larger size of hatchery steelhead, which behaviorally dominated most contests. They noted that these behavioral interactions between hatchery-reared steelhead did not appear to have impacted the trout populations examined to a statistically significant degree, however, and that the population abundance of naturally produced salmonids did not appear to have been negatively affected by releases of hatchery steelhead.

Competition between hatchery and naturally produced salmonids in freshwater may only present a risk for Coho, Chinook salmon, steelhead, and sockeye, since pink and chum salmon do not rear for extended periods in freshwater (SIWG 1984). Studies indicate that hatchery Coho salmon have the potential to adversely impact certain naturally produced salmonid species through competition. Information suggests that juvenile Coho salmon are behaviorally dominant in agonistic encounters with juveniles of other stream-rearing salmonid species, including Chinook salmon, steelhead, and cutthroat trout (*O. clarki*), and with wild-origin Coho salmon (e.g., Stein et al. 1972; Allee 1974; Swain and Riddell 1990; Taylor 1991). Dominant salmonids tend to capture the most energetically profitable stream positions (Fausch 1984; Metcalfe et al. 1986), providing them with a potential survival advantage over subordinate fish. However, where interspecific populations have evolved sympatrically, Chinook salmon and steelhead have evolved slight differences in habitat use patterns that minimize their interactions with Coho salmon (Nilsson 1967; Lister and Genoe 1970; Taylor 1991).

There is a hypothesis that large numbers of hatchery-produced smolts released into the Columbia River have adverse effects on naturally produced smolts in the migration corridor and ocean. This hypothesis assumes that there is a limitation on the capacity of the migration corridor and ocean and that there are adverse interactions between hatchery-produced and naturally produced smolts.

Interactions between hatchery juveniles and naturally produced fish in the migration corridor have been reduced by decreases in the number of hatchery fish released by Columbia River basin hatchery programs and by the mortality of hatchery fish after release. A production ceiling for all artificial propagation programs in the Columbia River basin was described in the Proposed Recovery Plan (NMFS 1995c) and in the 1999 artificial propagation Biological Opinion (NMFS 1999a). This production ceiling was approximately 197.4 million anadromous fish. In 2007, an estimated 141.1 million smolts were released into the Columbia River basin, which is well below the production ceiling. Although releases occur throughout the year, approximately 80 percent occur from April through June. A significant portion of these releases do not survive to the Snake and Columbia River migration corridors. For example, the historical passage index of hatchery fish released into the Snake River Basin surviving to Lower Granite Dam shows a ratio of 0.23 for spring/summer Chinook salmon and 0.60 for steelhead; for hatchery releases in the Columbia River above McNary Dam the ratio is 0.185 for spring/summer Chinook salmon, 0.477 for sub-yearling Chinook salmon, 0.093 for steelhead, and 0.215 for Coho salmon (FPC 1992). While the actual number of hatchery fish entering the Columbia River migration corridor is unknown, it is substantially less than the numbers released.

The speed of travel of upriver smolts also serves to reduce interaction and competition in the mainstem of the Columbia and the estuary. Bell (1984) gives rates of 13 miles/day (21 km/day) low flows and 23 miles/day (38 km/d) in moderate flows, as a general average for downstream migrants. Dawley et al. (1986) found rates of 1 to over 59 km/day in the estuary, depending on size, species and distance traveled, with the faster rates correlated with larger smolts from further upriver. In the free-flowing reaches of the Snake, Clearwater and Salmon, currents in excess of 10 km/hr are common during the spring freshet. Smolts could move in excess of 100 km/d just by holding in the thalweg, but the literature would indicate 40 to 50 km/day is a more likely average in moderate to high flows.

As occurs in rearing areas, habitat partitioning in the migration corridor among the species has evolved to reduce interspecific competition. Bell (1984) and Dawley et al. (1986) comment on differential habitat selection with steelhead choosing the thalweg and nearer to the surface, subyearling Chinook salmon being more likely to follow the shorelines and yearling Chinook salmon seeking greater depths.

Historically the bulk of the Columbia River adult returns were spring and summer Chinook salmon, Coho salmon, sockeye salmon, and steelhead. Chapman (1986) calculated only 1.25 million adult fall Chinook salmon historically returned to the Columbia River, in his high estimate, so over 80 percent of the smolts would have been spring migrating, yearling smolts. Therefore, 160 to 320 million spring, yearling smolts (based on historic returns of approximately 10 million salmon and steelhead) would have passed through the estuary and entered the ocean in May and June each year, compared to less than 40 million under current conditions. In the past, when hatchery production in the basin reached nearly 200 million fish, over half of the production was fall Chinook salmon that produce sub-yearling, summer-migrating smolts, thus limiting potential to exceed the capacity of the migration corridor.

Habitat partitioning and speed of travel should function to reduce predation, competition and interspecies interactions. The reduced number of smolts in the corridor should also decrease the potential for detrimental interactions. However, the behavior of fish in the hydropower reservoirs and bottlenecks in collection and transportation systems may increase opportunities for interaction. Smolts may be disoriented by slack water and may be concentrated as the fish traveling 50 km/d in free-flowing rivers catch up to the fish traveling 10 km/d in the reservoirs. Smolts have been observed to concentrate in front of dams before they enter the collection system. In the collection and transportation system any habitat partitioning is eliminated, densities are increased and both inter- and intra-specific interactions are forced.

Considerable speculation, but little scientific information, is available concerning the overall impacts on listed salmon and steelhead from the combined number of hatchery fish in the Columbia River migration corridor. In a review of the literature, Steward and Bjornn (1990) indicated that some biologists consider density-dependent mortality during freshwater migration to be negligible; however, they also cited a steelhead study that indicated there may have been a density-dependent effect (Royal 1972, cited in Steward and Bjornn 1990). Hatchery and natural populations have similar ecological requirements and can potentially be competitors where critical resources are in short supply (Lower Granite Migration Study Steering Committee (LGMSC 1993).

The limited information available concerning impacts from changes in the historic carrying capacity to listed salmon is insufficient to determine definitive effects. It is for this reason that NMFS has called for a limitation of hatchery releases in the Columbia Basin. The effects of hatchery production on listed salmon and steelhead in the ocean would be speculative, since hatchery fish intermingle at the point of ocean entry with wild and hatchery anadromous salmonids from many other regions. Witty et al. (1995) assessing the effects of Columbia River hatchery salmonid production on wild fish stated:

> "We have surmised the ocean fish rearing conditions are dynamic. Years of limited food supply affect size of fish, and reduced size makes juveniles more subject to predation (quoted from Parker 1971). Mass enhancement of fish populations through fish culture could cause density-dependant affects during years of low ocean productivity. However, we know of no studies which demonstrate, or even suggest, the magnitude of changes in numbers of smolts emigrating from the Columbia River Basin which might be associated with some level of change in survival rate of juveniles in the ocean. We can only assume that an increase in smolts might decrease ocean survival rate and a decrease might improve ocean survival rate."

However, the assumptions made by Witty et al. (1995) would apply only if the ocean were near carrying capacity. The current production from the Columbia River is lower than the number carried by the migration corridor and ocean in the fairly recent past.

The species of primary concern in the Columbia Basin are Chinook salmon, sockeye salmon and steelhead. There is no evidence in the literature to support the speculation that there is some compensatory mortality of Chinook salmon and steelhead in the ocean environment. There is evidence of density-dependent compensatory ocean survival in the cases of massive pink and chum salmon hatchery programs in Alaska, Russia and Japan (Pearcy 1992). There are currently two small chum salmon hatchery programs in the Lower Columbia River, the WDFW's Grays River program (including Chinook salmon River releases) and the Duncan Creek program below Bonneville Dam. These produce chum salmon at a level that is only a fraction of a percent of the numbers seen in Alaska, Russia and Japan. Pink salmon are functionally extinct in the Columbia River.

The SIWG (1984) acknowledged that the risk of adverse competitive interactions in marine waters is difficult to assess, because of a lack of data collected at times when hatchery fish and naturally produced fish likely interact, and because competition depends on a variety of specific circumstances associated with hatchery-naturally produced fish interaction, including location, fish size, and food availability. In marine waters, the main limiting resource for naturally produced fish that could be affected through competition posed by hatchery-origin fish is food. The early marine life stage, when naturally produced fish have recently entered the estuary and populations are concentrated in a relatively small area, may create short term instances where food is in short supply, and growth and survival declines as a result (SIWG 1984). This period is viewed as of special concern regarding food resource competition posed by hatchery-origin chum salmon and pink salmon to naturally produced chum salmon and pink salmon populations (Cooney et al. 1978; Simenstad et al. 1980; Bax 1983). The degree to which food is limiting after the early marine portion of a naturally produced fish's life depends upon the density of prey species. This does not discount limitations posed on naturally produced fish in more seaward areas as a result of competition by hatchery-origin fish, as data are available that suggests that marine survival rates for salmon are density dependent, and thus possibly a reflection of the amount of food available (SIWG 1984).

The risk of adverse competitive interactions can be minimized by:

- Releasing hatchery smolts that are physiologically ready to migrate. Hatchery fish released as smolts emigrate seaward soon after liberation, minimizing the potential for competition with juvenile naturally produced fish in freshwater (Steward and Bjornn 1990).
- Operating hatcheries such that hatchery fish are reared to sufficient size that smoltification occurs within nearly the entire population.
- Rearing juvenile hatchery fish on parent river water, or acclimating them for several weeks to parent river water, will contribute to the smoltification process and reduced retention time in the streams.
- Releasing hatchery smolts after the major seaward emigration period for naturally produced salmonid populations to minimize the risk of interaction that may led to competition.

The goal of the program is to release 150,000 functional yearling smolts that quickly migrate to the ocean consistent with minimizing interactions with naturally produced spring Chinook salmon. The number of fish to be releases is set at a level consistent with estimates of available habitat to decrease the risk of density-dependent effects. In some years, due to higher than anticipated survival or success of captive spawners, the eggtake from captive broodstock could necessitate releasing some fry into the White River as a mechanism to maintain the yearling smolt group to the 150,000 fish target. Impacts from fry releases would be minimized through permit terms and conditions that would require that fry could be released only in areas where habitat is vacant or under-seeded based on monitoring information such as snorkel surveys or redd surveys. NMFS finds that following the steps listed above adequately minimizes the risk to the natural population.

4.2.6 Predation

Risks to naturally produced salmonids attributable to direct predation (direct consumption) or indirect predation (increases in predation by other predator species due to enhanced attraction) can result from hatchery salmonid releases in freshwater and estuarine areas. Hatchery-origin fish may prey upon juvenile naturally produced salmonids at several stages of their life history. Newly released hatchery smolts have the potential to prey on naturally produced fry and fingerlings that are encountered in freshwater during downstream migration, or if the hatchery fish residualize prior to migrating. Hatchery-origin smolts, sub-adults, and adults may also prey on naturally produced fish of susceptible sizes and life stages (smolt through sub-adult) in estuarine and marine areas where they commingle. Hatchery salmonids planted as non-migrant fry or fingerlings, and progeny of naturally spawning hatchery fish also have the potential to prey upon natural-origin salmonids in freshwater and marine areas where they co-occur. In general, naturally produced salmonid populations will be most vulnerable to predation when naturally produced populations are depressed and predator abundance is high, in small streams, where migration distances are long, and when environmental conditions favor high visibility. SIWG (1984) categorized species combinations as to whether there is a high, low, or unknown risk that direct predation by hatchery fish will have a negative impact on productivity of naturally produced salmonids (Table 8).

The SIWG (1984) rated most risks associated with predation as unknown, because, although there is a high potential that hatchery and naturally produced species interact, due to a high probability of spatial and temporal overlap, there was relatively little literature documentation of predation interactions in either freshwater or marine areas. Predation may be greatest when large numbers of hatchery smolts encounter newly emerged fry or fingerlings, or when hatchery fish are large relative to naturally produced fish (SIWG 1984). Some reports suggest that hatchery fish can prey on fish that ½ their length (Pearsons and Fritts 1999), but other studies have concluded that salmonid predators prefer smaller fish and are generally thought to prey on fish 1/3 or less their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1992; CBFWA 1996). Hatchery fish may also be less efficient predators as compared to their natural-origin co-specifics reducing the potential for predation impacts (Sosiak et al. 1979; Bachman 1984; Olla et al. 1998).

Due to their location, size, and time of emergence, newly emerged salmonid fry are likely to be the most vulnerable to predation by hatchery released fish. Their vulnerability is believed to be greatest as they emerge and decreases somewhat as they move into shallow, shoreline areas (USFWS 1994). Emigration out of hatchery release areas and foraging inefficiency of newly released hatchery smolts may minimize the degree of predation on salmonid fry (USFWS 1994).

Table 9. Risk of hatchery salmonid species predation on naturally produced salmonid species in freshwater areas (SIWG 1984).

Hatchery Species	Naturally produced Species					
	Steelhead	Pink Salmon	Chum Salmon	Sockeye Salmon	Coho Salmon	Chinook Salmon
Steelhead	U	H	H	H	U	U
Pink Salmon	L	L	L	L	L	L
Chum salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	U	H	H	H	U	U
Chinook Salmon	U	H	H	H	U	U

Note: "H" = High risk; "L" = Low risk; and "U" = Unknown risk of a significant impact occurring.

Although considered as of “unknown” risk by SIWG (1984), data from hatchery salmonid migration studies on the Lewis River, Washington (Hawkins and Tipping 1998) provide evidence of hatchery coho salmon yearling predation on salmonid fry in freshwater. The WDFW Lewis River study indicated low levels of hatchery steelhead smolt predation on salmonids. In a total sample of 153 out-migrating hatchery-origin steelhead smolts captured through seining in the Lewis River between April and June 24, 12 fish (7.8 percent) were observed to have consumed juvenile salmonids (S. Hawkins, WDFW, personal communication, July 1997). The juvenile salmonids contained in the steelhead stomachs appeared to be Chinook salmon fry. Sampling through this study indicated that no emergent wild-produced steelhead or trout fry (30-33 mm fl) were present during the first two months of sampling. Hawkins (1998) documented hatchery spring Chinook salmon yearling predation on naturally produced fall Chinook salmon juveniles in the Lewis River. A small number of spring Chinook salmon smolts were sampled (11), and remains of 10 salmonids were found (includes multiple observations of remains from some smolts). Predation on smaller Chinook salmon was found to be much higher in naturally produced smolts (Coho salmon and cutthroat predominately) than their hatchery counterparts. Steward and Bjornn (1990) referenced a report from California that estimated, through indirect calculations, rather than actual field sampling methods, the potential for substantial predation impacts by hatchery yearling Chinook salmon on naturally produced Chinook salmon and steelhead fry. They also reference a study in British Columbia that reported no evidence of predation by hatchery Chinook salmon smolts on emigrating naturally produced Chinook salmon fry in the Nicola River. In addition, Bakkala (1970 - quoting Hunter (1959) and Pritchard (1936)) reported that young coho salmon in some British Columbia streams averaged two to four chum salmon fry per stomach sampled.

Predation by hatchery fish on natural-origin smolts or sub-adults is less likely to occur than predation on fry. Coho salmon and Chinook salmon, after entering the marine environment, generally prey upon fish one-half their length or less and consume, on average, fish prey that is less than one-fifth of their length (Brodeur 1991). During early marine life, predation on naturally produced Chinook salmon, coho, and steelhead will likely be highest in situations where large, yearling-sized hatchery fish encounter sub-yearling fish or fry (SIWG 1984). Juanes (1994), in a survey of studies examining prey size selection of piscivorus fishes, showed a consistent pattern of selection for small-sized prey. Hargreaves and LeBrasseur (1985; 1986) reported that coho salmon smolts ranging in size from 100-120 mm fl selected for smaller chum salmon fry (sizes selected 43-52 mm fl) from an available chum salmon fry population including larger fish (available size range 43-63 mm fl). Ruggerone (1989; 1992) also found that coho salmon smolts (size range 70-150 mm fl) selected for the smallest sockeye fry (28-34 mm fl) within an available prey population that included larger fish (28-44 mm fl). However, extensive stomach content analyses of coho salmon smolts collected through several studies in marine waters of Puget Sound, Washington, do not substantiate any indication of significant predation upon juvenile salmonids (Simenstad and Kinney 1978). Similarly, Hood Canal, Nisqually Reach, and north Puget Sound data show little or no evidence of predation on juvenile salmonids by juvenile and immature Chinook salmon (Simenstad and Kinney 1978). In a recent literature review of Chinook salmon food habits and feeding ecology in Pacific Northwest marine waters, Buckley (1999) concluded that cannibalism and intra-generic predation by Chinook salmon are rare events. Likely reasons for apparent low predation rates on salmon juveniles, including

Chinook salmon, by larger Chinook salmon and other marine predators suggested by Cardwell and Fresh (1979) include:

- The rapid growth in fry, resulting in the increased ability to elude predators and becoming accessible to a smaller proportion of predators due to size alone.
- The rapid dispersal of fry, making them present in lower densities relative to other fish and invertebrate prey.
- The learning or selection for some predator avoidance.

Large concentrations of migrating hatchery fish may attract predators (birds, fish, and seals) and consequently contribute indirectly to predation of emigrating naturally produced fish (Steward and Bjornn 1990). The presence of large numbers of hatchery fish may also alter naturally produced salmonid behavioral patterns, potentially influencing their vulnerability and susceptibility to predation (Hillman and Mullan 1989; USFWS 1994). Hatchery fish released into naturally produced fish production areas, or into migration areas during naturally produced fish emigration periods, may therefore pose an elevated, indirect predation risk to commingled listed fish. Alternatively, a mass of hatchery fish migrating through an area may overwhelm established predator populations, providing a beneficial, protective effect to co-occurring listed naturally produced fish.

Hatchery impacts from predation can be minimized by:

- Releasing actively migrating smolts through volitional release practices.
- Insuring that a high proportion of the population is smolted prior to release using minimum coefficient of variation population size limits. Smolts tend to migrate seaward rapidly when fully smolted, limiting the duration of interaction between hatchery fish and naturally produced fish present within, and downstream of, release areas.
- Delaying hatchery fish releases until the major seaward emigration period for naturally produced salmonid populations has been completed can minimize the risk of interaction that may led to predation.
- Releasing hatchery smolts in lower river areas, below upstream areas used for stream-rearing young-of-the-year naturally produced salmon fry, reducing the likelihood for interaction between the hatchery and naturally produced fish.
- Operating hatchery programs and releases to minimize the potential for residualism (see discussion below).

This program is intended to enhance the endangered population of spring Chinook salmon in the Wenatchee basin. As discussed above, predation by spring Chinook salmon is not likely to occur.

4.2.7 Residualism

Artificially propagated smolts are released into rivers and streams with the anticipation that they will migrate to the ocean. In many cases, some portion of the hatchery-produced juveniles will "residualize", or become residents of the receiving water for an extended period of a year or more. The general effects of hatchery-produced fish on natural fish, as described by Steward and

Bjornn (1990) may be exacerbated if a substantial portion of the hatchery-produced juvenile salmonids residualize.

Coho salmon in most situations do not have the same potential to residualize as steelhead, but approximately 6 percent of the coho salmon planted as parr residualized in the receiving stream in the Clearwater River drainage for a year after release (Johnson and Sprague 1996). Coho salmon parr stocked in 1995, were observed two years after release in snorkel surveys and screw traps (BIA 1998) and about 2,000 age two coho salmon smolts were counted at Snake River mainstem dams (FPC in BIA 1998). So far there does not appear to be any residualism of coho salmon smolts released into the Yakima and Methow Rivers (T. Scribner, YN, personal communication).

Ocean-type Chinook salmon, like the fall Chinook salmon of the Snake River and mid-Columbia generally begin migration towards salt water soon after emergence, however some may spend up to one year before undertaking the smolt migration (Healey 1991). In the Snake River, Connor et al. (1992) report a small percentage of hatchery-produced fall Chinook salmon smolts spend more than a year as residents in the Snake River before smolting. Although most stream-type Chinook salmon juveniles become smolts in the spring one year after emergence, some may spend a second year in fresh water, particularly slower- growing individuals. This effect may be related to cooler water temperatures in more northern or higher elevation waters (Healey 1991).

The variability in life history exhibited by naturally produced anadromous salmonids probably has some adaptive and survival advantages. By allowing slow-growing fish extra time in freshwater this strategy may ensure smolts that are large enough to improve migration survival. That not all spawners are the same age allows transfer of genetic material between brood years of a population and protects against loss of an entire spawning year to a single natural catastrophe. Adaptability to cooler water or less productive water by extending freshwater residency may allow anadromous fish to occupy a greater variety of habitats. The current conventional wisdom on hatchery management would support the standardization of life history and the rearing protocols which produce smolts on a single, uniform, schedule, but this practice may be intentionally selecting away from the genetic heritage of the fish. For supplementation hatchery programs and as artificial propagation practices include more natural rearing environments, hatchery managers may have to accommodate variable life histories in production protocols.

Residualism is primarily a concern for releases of hatchery steelhead and not spring Chinook salmon, fall Chinook salmon, and Coho salmon. Therefore, residualism would not be expected to be substantial or reduce the likelihood of the persistence or recovery of the White River spawning aggregate, the Wenatchee population, or the ESU as a whole.

4.2.8 Nutrient Cycling

The flow of energy and biomass from productive marine environments to relatively unproductive terrestrial environments supports high productivity in the ecotone where the two ecosystems meet (Polis and Hurd 1996). Anadromous salmon are a major vector for transporting marine nutrients across ecosystem boundaries (i.e. from marine to freshwater and terrestrial ecosystems). Because of the long migrations of some stocks of Pacific salmon, the link between marine and terrestrial production may be extended hundreds of miles inland. Nutrients and biomass extracted from the milt, eggs, and decomposing carcasses, of spawning salmon stimulate growth and restore the nutrients of aquatic ecosystems. Nutrients originating from salmon carcasses are also important to riparian plant growth. Direct consumption of carcasses and secondary consumption of plants and small animals that are supported by carcasses is an important source of nutrition for terrestrial wildlife (Cederholm et al. 1999).

Current escapements of naturally produced and naturally spawning hatchery-produced anadromous salmonids in the Columbia Basin are estimated at about 7 percent of the historic biomass (Cederholm et al. 1999). Throughout the Pacific Northwest, the delivery of organic nitrogen and phosphorus to the spawning and rearing streams for anadromous salmonids has been estimated at 5 to 7 percent of the historic amount (Gresh et al. 2000). Cederholm et al. (1999) calculate the historical spawning escapement at 45,150 metric tons of biomass annually added to the aquatic ecosystems of the Columbia compared to 3,400 metric tons annually with current spawning escapements.

Artificial propagation programs in the basin add substantial amounts of fish biomass to the freshwater ecosystem. The annual hatchery production cap of nearly 200 million smolts, at 25 g/smolt average weight, adds about 5,000 metric tons of biomass to the Columbia Basin. Returning adults from artificial propagation programs have totaled 800,000 to 1,000,000 in recent years (ODFW and WDFW 1998). At the average weight of 6.75 kg used by Cederholm et al. (1999), 5,400 to 6,750 metric tons of fish biomass is potentially returned to the Columbia River annually due to artificial propagation programs. Of course, most of the hatchery smolt production is expected to leave freshwater and migrate to the marine ecosystem, but undoubtedly some is retained in freshwater and terrestrial ecosystems as post-release mortalities and consumption by predators such as bull trout, ospreys and otters. Much of the adult return from hatchery production may be removed from the ecosystem by selective fisheries or taken at hatchery weirs and traps.

However, the potential to utilize the marine-derived nutrients that are imported to freshwater ecosystems in the carcasses of hatchery returns may be of value for stimulating ecosystem recovery. Experiments have shown that carcasses of hatchery-produced salmon can be an important source of nutrients for juvenile salmon rearing in streams (Bilby et al. 1998). Hatchery carcasses may also replace some of the nutrient deficit in riparian plant and terrestrial wildlife communities where naturally produced spawners are lacking. The contribution of artificial propagation programs has the potential to exceed the contribution of naturally produced fish in replenishing the nutrient capital of aquatic ecosystems in the short term, but should not be regarded as a long term solution to replacing the nutrient subsidy provided by naturally produced salmon. The adult carcasses from the proposed program would remain in the stream to provide nutrients and would have minimal or no effect on the population. The added nutrients to the White River basin from the proposed program may have a slight, but likely not measurable, benefit to the freshwater ecosystem. Therefore, NMFS finds that such minor inputs of nutrients are not likely to measurably affect the Wenatchee population or the UCR spring Chinook salmon ESU as a whole.

4.2.9 Masking

Returning adult hatchery fish can stray into natural spawning areas confounding the ability to determine the annual abundance of naturally produced fish. This can lead to an over-estimation of the actual abundance and productivity of the natural population, and to an inability to assess the health and production potential of the critical habitat for that population. This latter factor exists because the hatchery fish are not subject to the same spawning and early life history productivity limits experienced by the natural population in the natural freshwater environment. The abundance and productivity of the naturally produced fish and the health of the habitat that sustains them, is therefore "masked" by the continued infusion of hatchery-produced fish.

Masking of natural fish status by naturally spawning hatchery fish produced for harvest augmentation purposes was one basis for the recommended listing of the Puget Sound Chinook salmon ESU as "threatened" under the ESA (Myers et al. 1998). Annual spawning ground censuses of fall Chinook salmon populations had historically aggregated naturally spawning hatchery and naturally produced fish. When an identifying mark was applied to a proportion of the hatchery fish, efforts were made to subtract out hatchery fish from escapement estimates through expanded mark recovery estimates. In many instances, however, the release of unmarked hatchery fall Chinook salmon groups, predominately of a single stock, led to the situation where salmon spawning escapement abundances were artificially sustained, and the actual annual abundances of the indigenous naturally produced fall Chinook salmon populations in some watersheds were over-estimated or unknown. The situation in the Puget Sound has been corrected and now all hatchery-origin Chinook salmon are marked.

Attempts to identify and remedy anthropogenic factors adversely affecting fish habitat may be impeded through masking of natural fish status. For example, instability and degradation of spawning gravel areas through flooding during critical spawning or egg incubation periods may not be recognized as a limiting factor to natural production if annual spawning ground censuses are subsidized by returning adults from annual hatchery releases. If the vast majority of the adult fish observed were of direct hatchery origin, the poor natural productivity status of the spawning areas will not be evident without additional, expansive monitoring efforts.

Resolution of the masking issue can be achieved by:

- Providing an effective means to easily differentiate hatchery fish from natural-origin fish on the spawning grounds. A readily visible external mark applied to hatchery fish prior to release, combined with an effective spawning ground census program designed to derive separate estimates of hatchery and natural fish, is one avenue available. Mass marking of hatchery fish using an internal mark (e.g., otolith banding) may also be used to differentiate hatchery from natural-origin fish on the spawning grounds, if a statistically valid adult sampling design to collect and analyze mark recovery data is also implemented.
- Plant or release fish only in areas where "masking" is not an issue but still mark enough fish to monitor straying.
- Removing hatchery fish through selective fisheries or at weirs and dams.

- Imprinting hatchery fish to return to lower river or tributary areas not used by natural fish in a watershed.
- Reducing or limiting hatchery fish release numbers leading to decreased adult hatchery fish returns may also reduce masking effects.

The proposed program minimizes risks associated with masking of the natural populations by hatchery reared fish by marking or tagging hatchery reared fish such that they can be identified when they return to the White River.

4.2.10 Fisheries

Fisheries managed for, or directed at, the harvest of hatchery-origin fish have been identified as one of the primary factors leading to the decline of many naturally produced salmonid stocks (Flagg et al. 1995; Myers et al. 1998). Depending on the characteristics of a fishery regime, the commercial and recreational pursuit of hatchery fish can lead to the harvest of naturally produced fish in excess of levels compatible with their survival and recovery (NRC 1996). Listed salmon and steelhead may be intercepted in mixed stock fisheries targeting predominately returning hatchery fish or healthy natural stocks (Mundy 1997). Fisheries can be managed for the aggregate return of hatchery and naturally produced fish, which can lead to higher than expected harvest of naturally produced stocks.

The proposed program is not intended to provide fish for fisheries. Therefore, no risks from fisheries are posed from implementing the proposed program.

4.2.11 Monitoring and Evaluation/Research

Monitoring and Evaluation programs are necessary to determine the performance of artificial propagation programs. The Artificial Production Review (NPPC 1999) listed four criteria for evaluating both augmentation and mitigation programs:

1. Has the hatchery achieved its objectives?
2. Has the hatchery incurred costs to natural production?
3. Are there genetic impacts associated with the hatchery production?
4. Is the benefit greater than the cost?

Historically, hatchery performance was determined solely on the hatchery's ability to release fish (NPPC 1999), this was further expanded to include hatchery contribution to fisheries (e.g. Wallis 1964; Wahle and Vreeland 1978; Vreeland 1989). Past program-wide reviews of artificial propagation programs in the Northwest have indicated that monitoring and evaluation has not been adequate to determine if the hatchery objectives are being met (ISG 1996; NRC 1996; NFHRP 1994). The lack of adequate monitoring and evaluation has resulted in the loss of information that could have been used to adaptively manage the hatchery programs (NRC 1996).

Under the ESA, monitoring and evaluation programs for artificial production are not only necessary for adaptive management purposes but are required to ensure that artificial propagation activities do not limit the recovery of listed populations. Monitoring and evaluation of artificial propagation activities are necessary to determine if management actions are adequate to reduce or minimize the impacts from the general effects discussed previously, and to determine if the hatchery is meeting its performance goals. Monitoring and evaluation activities will occur within the hatchery facilities as well as in the natural production areas. Monitoring and evaluation within the hatchery can include measurements to evaluate hatchery production (i.e., survival, nutrition, size at age, condition, disease prevention, genetic makeup, total released, percent smolted, etc.).

Monitoring and evaluation to determine impacts on listed fish from artificial propagation programs can itself have potential adverse impacts on listed fish in the hatchery though injuries incurred during sampling and marking. Sampling within the hatchery can include direct mortalities (e.g., genetic analysis, disease pathology, smolt condition) and indirect take (e.g. sorting, marking, transfers). Marking of hatchery fish prior to release is required for all programs to monitor and evaluate hatchery effects (positive and negative). Marking is necessary to evaluate a number of objectives including selecting broodstock, determining hatchery stray rates and hatchery contributions to fisheries, and for the implementation of selective fisheries that target hatchery fish.

For hatchery supplementation programs, the goal is to promote the viability of natural-origin populations as the factors limiting viability are reduced by using hatchery fish to increase the number of natural spawners. Monitoring and evaluation for this goal requires the sampling of naturally produced adults and juveniles in natural production areas. In the Columbia River Basin, many of these naturally produced populations are listed under the ESA.

Monitoring and evaluating fish and fish assemblages in the natural environment is necessary to determine any positive or negative effects the artificial production program is having on the natural population. Genetic and life-history data may need to be collected from the natural population to determine if the hatchery population has diverged from the natural population and if the natural population has been altered by the incorporation of hatchery fish into the spawning population. Sampling methods can include the use of weirs, electro-fishing, rotary screw traps, seines, hand nets, spawning ground surveys, snorkeling, radio tagging, and carcass recovery. Each sampling method can be used to collect a variety of information. Sample methods, like tagging methods, can adversely impact listed fish, both those targeted for data collection and those taken incidentally to the data collection.

The primary effects the proposed activities will have on listed fish will occur in the form of intentional "take" (the ESA take definition is given in the section introducing the individual permits), a major portion of which comes in the form of harassment. Harassment generally leads to stress and other sub-lethal effects and is caused by observing, capturing, and handling fish. The ESA does not define harassment nor has NMFS defined this term through regulation. However, the U.S. Fish and Wildlife Service defines harassment as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to breeding, feeding or sheltering" [50 CFR 17.3]. For the purposes of this biological opinion, NMFS adopts this definition of harassment.

The various proposed activities would cause many types of take, and while there is some blurring of the lines between what constitutes an activity and what constitutes a take category (e.g., harm), it is important to keep the two concepts separate. The reason for this is that the effects being measured here are those which the activity itself has on the listed species. They may be expressed in *terms* of the take categories (e.g., how many UCR spring Chinook and steelhead are harmed, or harassed, or even killed), but the actual mechanisms of the effects themselves (i.e., the activities) are the causes of whatever take arises and, as such, they bear examination. Therefore, the first part of this section is devoted to a discussion of the general effects known to be caused by the proposed activities—regardless of where they occur or what species are involved.

The following subsections describe the types of activities being proposed. Because they would all be carried out by trained professionals using established protocols and have widely recognized specific impacts, each activity is described in terms broad enough to apply to every proposed permit. This is especially true in light of the fact that the researchers would not receive a permit unless their activities incorporate NMFS' uniform, pre-established set of mitigation measures.

<u>Observation</u>

For some parts of the monitoring and evaluation, listed fish will be observed in-water (e.g., by snorkel surveys). Direct observation is the least disruptive method for determining presence/absence of the species and estimating their relative abundance. Its effects are also generally the shortest-lived among any of the research activities discussed in this section. Typically, a cautious observer can effectively obtain data without disrupting the normal behavior of a fish. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may temporarily leave a particular pool or habitat type when observers are in their area. Researchers minimize the amount of disturbance by moving through streams slowly—thus allowing ample time for fish to reach escape cover; though it should be noted that the research may at times involve observing adult fish—which are more sensitive to disturbance. During some of the research activities discussed below, redds may be visually inspected, but no redds will be walked on. Harassment is the primary form of take associated with these observation activities, and few if any injuries or deaths are expected to occur—particularly in cases where the observation is to be conducted solely by researchers on the stream banks rather than in the water. There is little a researcher can do to mitigate the effects associated with observation activities because those effects are so minimal. In general, all they can do is move with care and attempt to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves.

<u>Capture/handling</u>

Capturing and handling fish causes them stress—though they typically recover fairly rapidly from the process and therefore the overall effects of the procedure are generally short-lived. The primary contributing factors to stress and death from handling are excessive doses of anesthetic, differences in water temperatures (between the river and wherever the fish are held), dissolved oxygen conditions, the amount of time that fish are held out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18EC or dissolved oxygen is below saturation. Fish that are transferred to holding tanks can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps if the traps are not emptied on a regular basis. Debris buildup at traps can also kill or injure fish if the traps are not monitored and cleared on a regular basis.

Based on prior experience with the research techniques and protocols that would be used to conduct the proposed scientific research, no more than five percent of the juvenile salmonids encountered are likely to be killed as an unintentional result of being captured and handled and, in most cases, that figure will not exceed three percent. In addition, it is not expected that more than one percent of the adults being handled will die. In any case, all researchers will adhere to the conditions described earlier and thereby keep adverse effects to a minimum. Finally, any fish unintentionally killed by the research activities in the proposed permits may be retained as reference specimens or used for analytical purposes.

Tagging/marking

Techniques such as PIT-tagging (passive integrated transponder tagging), coded wire tagging, fin-clipping, and the use of radio transmitters are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver (e.g., any of several dams) without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled, therefore any researchers engaged in such activities will follow the conditions listed previously in this Opinion (as well as any permit-specific conditions) to ensure that the operations take place in the safest possible manner. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice et al. 1987, Jenkins and Smith 1990, Prentice et al. 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith et al. (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically- or surgically implanted sham radio tags or PIT-tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller 1994) were similar to growth rates for salmon that were not tagged (Conner et al. 2001). Prentice and Park (1984) also found that PIT-tagging did not substantially affect survival in juvenile salmonids.

Coded wire tags (CWTs) are made of magnetized, stainless-steel wire. They bear distinctive notches or numbers that can be coded for such data as species, brood year, hatchery of origin, and so forth (Nielson 1992). The tags are intended to remain within the animal indefinitely, consequently making them ideal for long-term, population-level assessments of Pacific

Northwest salmon. The tag is injected into the nasal cartilage of a salmon and therefore causes little direct tissue damage (Bergman et al. 1968, Bordner et al. 1990). The conditions under which CWTs may be inserted are similar to those required for applying PIT-tags.

A major advantage to using CWTs is the fact that they have a negligible effect on the biological condition or response of tagged salmon; however, if the tag is placed too deeply in the snout of a fish, it may kill the fish, reduce its growth, or damage olfactory tissue (Fletcher et al. 1987, Peltz and Miller 1990). This latter effect can create problems for species like salmon because they use olfactory clues to guide their spawning migrations (Morrison and Zajac 1987).

In order for researchers to be able to determine later (after the initial tagging) which fish possess CWTs, it is necessary to mark the fish externally—usually by clipping the adipose fin—when the CWT is implanted (see text below for information on fin clipping). One major disadvantage to recovering data from CWTs is that the fish must be killed in order for the tag to be removed. However, this is not a significant problem because researchers generally recover CWTs from salmon that have been taken during the course of commercial and recreational harvest (and are therefore already dead).

Another primary method for tagging fish is to implant them with radio tags. There are two main ways to accomplish this and they differ in both their characteristics and consequences. First, a tag can be inserted into a fish's stomach by pushing it past the esophagus with a plunger. Stomach insertion does not cause a wound and does not interfere with swimming. This technique is benign when salmon are in the portion of their spawning migrations during which they do not feed (Nielson 1992). In addition, for short-term studies, stomach tags allow faster post-tagging recovery and interfere less with normal behavior than do tags attached in other ways.

The second method for implanting radio tags is to place them within the body cavities of (usually juvenile) salmonids. These tags do not interfere with feeding or movement. However, the tagging procedure is difficult, requiring considerable experience and care (Nielson 1992). Because the tag is placed within the body cavity, it is possible to injure a fish's internal organs. Infections of the sutured incision and the body cavity itself are also possible, especially if the tag and incision are not treated with antibiotics (Chisholm and Hubert 1985, Mellas and Haynes 1985).

Fish with internal radio tags often die at higher rates than fish tagged by other means because radio tagging is a complicated and stressful process. Mortality is both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). Acute mortality is caused by trauma induced during capture, tagging, and release. It can be reduced by handling fish as gently as possible. Delayed mortality occurs if the tag or the tagging procedure harms the animal in direct or subtle ways. Tags may cause wounds that do not heal properly, may make swimming more difficult, or may make tagged animals more vulnerable to predation (Howe and Hoyt 1982, Matthews and Reavis 1990, Moring 1990). Tagging may also reduce fish growth by increasing the energetic costs of swimming and maintaining balance.

Fin clipping is the process of removing part or all of one or more fins to alter a fish's appearance and thus make it identifiable. When entire fins are removed, it is expected that they will never grow back. Alternatively, a permanent mark can be made when only a part of the fin is removed or the end of a fin or a few fin rays are clipped. Although researchers have used all fins for marking at one time or another, the current preference is to clip the adipose, pelvic, or pectoral fins. Marks can also be made by punching holes or cutting notches in fins, severing individual fin rays (Welch and Mills 1981), or removing single prominent fin rays (Kohlhorst 1979). Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (e.g., Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly—especially those caused by partial clips.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., stomach sampling). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it and Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped Coho salmon fingerlings have a 100 percent recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are clipped. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality, but other studies have been less conclusive.

Regardless, any time researchers clip or remove fins, it is necessary that the fish be handled. Therefore, the same safe and sanitary conditions required for tagging operations also apply to clipping activities.

Permit 1592 would allow the Permit Holders to annually capture, handle, tissue sample, and release natural juvenile White River spring Chinook salmon. A large portion of the juvenile fish captured would receive tags and fin clips. In addition the Permit Holders would observe a large number of spawning fish, take tissue samples from dead, spawned-out fish, and rescue or salvage those fish deemed to need such intervention.

Juvenile Fish

Juvenile fish traps are generally operated to achieve a sample efficiency of four to percent of the total natural brood production of the target species, depending on the river size. In other parts the Wenatchee River basin, juvenile fish traps are currently authorized under other ESA permits (NMFS 2002a, 2003a,f) to monitor natural production of UCR spring Chinook salmon. In general, these traps result in mortality of less than two percent on target species and less than one percent on non-target species. In the Biological Opinion for permit 1203 (NMFS 1999d), the WDFW assumed mortality of listed UCR spring Chinook salmon would not exceed three percent. Based on experience since that time, the potential mortality impact has been revised to less than two percent on target species.

To determine the effect of the proposed action, it is necessary to compare them to the total outmigrant numbers for the Wenatchee population expected for these species. It is important to keep in mind the fact that the percentages reflect only the effect the proposed research would have on the natural components of the spring Chinook salmon and steelhead outmigration. If the take is placed in the context of all spring Chinook and steelhead expected to migrate out of the Wenatchee system, then the percentages of spring Chinook and steelhead that would be killed would be reduced even further. Therefore, the effect of this research is so small as to be negligible in terms of its effects on the natural components of the outmigrations and entirely discountable in terms of its impact on the listed species. This is especially true in light of the fact that the research is designed to generate critical monitoring data and will be an important tool in helping manage these depleted stocks and determine if the artificial propagation program is benefiting or harming the natural population.

Table 5. Percentages of outmigrants that may be handled and killed during the operation of a rotary smolt trap in the White River.

Species	Life Stage	Origin	Percentage of Outmigrants Handled	Percentage of Outmigrants Killed
UCR spring Chinook salmon	Juvenile	Natural	20% (1.5% of UCR spring Chinook in the Wenatchee River)	2.0% (0.15% of UCR spring Chinook in the Wenatchee River)
UCR steelhead	Juvenile	Natural	20% (0.4% of UCR steelhead in the Wenatchee River)	2.0% (0.04% of UCR steelhead in the Wenatchee River)

Though the negative effects of the research are very small, the researchers will reduce them even further by following NMFS' protocols, handling and holding fish as briefly as possible, and ceasing operations if mortality rates are higher than expected.

Adult Fish

Observation of live fish and sampling of dead carcasses would not result in the additional death of any adult spring Chinook salmon or steelhead in the White River. Given the critical nature of the research and the very real chance that not even one fish may be killed in any particular year, this level of loss is entirely discountable in terms of its effect on the species as a whole.

Thus in all cases, the overall percentage of additional lethal take is so small that it is highly unlikely to have any effect at all on the continued viability of any component of any listed species—let alone any ESU or DPS as a whole. This is especially true when one considers the facts that the information to be obtained from the research would be used to benefit the fish and the researchers will do everything they can to decrease even these negligible effects. Therefore, NMFS finds that the risks from monitoring and evaluation activities would be minimal.

4.3 Cumulative Effects

Cumulative effects are defined in 50 CFR §402.02 as "those effects of future State, tribal, local or private actions, not involving Federal activities, that are reasonably certain to occur in the action area considered in this biological opinion." For the purpose of this analysis, the action area is that part of the Columbia River Basin described in the Description of the Proposed Action section above. Future Federal actions, including the ongoing operation of the hydropower systems, hatcheries, fisheries, and land management activities will be reviewed through separate section 7 consultation processes. Non-Federal actions that require authorization under section 10 of the ESA, and are not included within the scope of this consultation, will be evaluated in separate section 7 consultations.

Future Tribal, state, and local government actions will likely to be in the form of legislation, administrative rules or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area which encompasses numerous government entities exercising various authorities and the many private landholdings, make any analysis of cumulative effects difficult and frankly speculative. This section identifies representative actions that, based on currently available information, are reasonably certain to occur. It also identifies some goals, objectives, and proposed plans by government entities; however, NMFS is unable to determine at this point in time whether any proposals will in fact result in specific actions.

State Actions

Each state in the Columbia River basin administers the allocation of water resources within its borders. Most streams in the basin are over appropriated even though water resource development has slowed in recent years. Washington closed the mainstem Columbia River to new water withdrawals, and is funding a program to lease or buy water rights. If carried out over the long term this might improve water quantity. The state governments are cooperating with each other and other governments to increase environmental protections, including better habitat restoration, and hatchery and harvest reforms. NMFS also cooperates with the state water resource management agencies in assessing water resource needs in the basin, and in developing flow requirements that will benefit listed fish. During years of low water, however, there could be insufficient flow to meet the needs of the fish. These government efforts could be discontinued or even reduced, so their cumulative effects on listed fish are unpredictable.

The state of Washington has various strategies and programs designed to improve the habitat of listed species and assist in recovery planning, including the Salmon Recovery Planning Act, a framework for developing watershed restoration projects. The state is developing a water quality improvement scheme through the development of TMDLs (total maximum daily loads). These programs could benefit the listed species if implemented and sustained.

In the past, Washington's economy was heavily dependent on natural resources, with intense resource extraction activity. The state's economy has changed over the last decade and it is likely to continue changing—with less large scale resource extraction, more targeted extraction methods, and significant growth in other economic sectors. Growth in new businesses is creating urbanization pressures with increased demands for buildable land, electricity, water supplies, waste disposal sites, and other infrastructure. Economic diversification has contributed to population growth and movement in the states, a trend likely to continue for the next few decades. Such population trends will place greater demands in the action area for electricity, water, and buildable land; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure development. The impacts associated with economic and population demands will affect habitat features, such as water quality and quantity, which are important to the survival and recovery of the listed species. The overall effect is likely to be negative, unless carefully planned for and mitigated.

Some of the state programs described above are designed to address these impacts. Also, Washington enacted a Growth Management Act to help communities plan for growth and address growth impacts on the natural environment. If the programs continue they may help lessen some of the potential adverse effects identified above.

Local Actions

Chelan County is participating in recovery planning for ESA-listed salmon and steelhead through the Upper Columbia Salmon Recovery Board. At this time, a draft recovery plan has been developed that is expected to improve conditions in the action area and migration corridor for UCR spring Chinook salmon and steelhead.

Tribal Actions

Tribal governments will continue to participate in cooperative efforts involving watershed and basin planning designed to improve fish habitat. The results from changes in Tribal forest and agriculture practices, in water resource allocations, and in changes to land uses are difficult to assess for the same reasons discussed under State and Local Actions. The earlier discussions related to growth impacts apply also to Tribal government actions. Tribal governments will need to apply comprehensive and beneficial natural resource programs to areas under their jurisdiction to produce measurable positive effects for listed species and their habitat.

Private Actions

The effects of private actions are the most uncertain. Private landowners may convert current use of their lands, or they may intensify or diminish current uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts. Whether any of these private actions will occur is highly unpredictable, and the effects even more so.

Summary

Non-Federal actions are likely to continue affecting the listed species. Whether these effects will increase or decrease is a matter of speculation. State, Tribal, and local governments are developing plans and initiatives to benefit listed fish, and they must be completely implemented and sustained in a comprehensive way before NMFS can consider them “reasonably foreseeable” in its analysis of cumulative effects.

4.4 Integration and Synthesis of Effect

NMFS' approach for determining whether the proposed actions are likely to jeopardize the continued existence of ESA-listed salmonids or destroy or adversely modify designated critical habitat is based on an analysis of the existing or potential adverse effects posed by the actions. NMFS has considered the risks in the above adverse effects assessment sections, and the resultant likelihood for survival and recovery of the listed salmon ESU and steelhead DPS under the environmental baseline, taken in context with cumulative effects of other on-going actions, in making its jeopardy determination.

The proposed program is expected to decrease short-term extinction risk within the White River spawning aggregation by increasing the abundance of White River lineage spring Chinook salmon on the spawning grounds. Based on a smolt release objective of 150,000 smolts, it is estimated that up to 450 adult spawners could be generated from the supplementation program in the near term. Potential effects on listed spring Chinook salmon include take that can be estimated in terms of the number of individuals impacted and as the result of more theoretical impacts that may result from artificial propagation in general, such as domestication, disease, competition, and predation. Potential effects on listed steelhead would be negligible because the very low number of steelhead spawning in the White River would be expected to result in very few juvenile steelhead that could be rearing in the area.

The White River recovery effort would complement artificial propagation programs in other key tributaries of the Wenatchee River population and is intended to contribute to an overall increase in abundance, maintain/enhance diversity and spatial distribution, and enhance productivity of the Wenatchee River Basin spring Chinook salmon population. Enhancing these population metrics (VSP criteria) for the Wenatchee River Basin spring Chinook salmon population is consistent with recovery criteria of the UCR spring Chinook salmon ESU describe by the Interior Columbia Technical Recovery Team (ICTRT 2007).

Juveniles

The total amount of estimated take for any of the broodstock collection strategies would be equivalent to one adult spring Chinook salmon. The potential benefit to the adult population is estimated at 450 spring Chinook salmon at a smolt-to-adult (SAR) survival rate of 0.3 percent. Even at a 0.1 percent SAR the abundance boost to the White River spring Chinook spawning aggregate could be 150 fish.

The vast majority (more than 98 percent) of the juvenile fish that would be captured, handled, tagged, etc., during the course of the proposed monitoring and evaluation activities are expected to survive with no long-term effects. Moreover, all the capture, handling, and holding methods will be minimally intrusive and of short duration. Because so many of the captured fish are expected to survive the research actions and so few (less than one half of one percent) of the outmigrants from any species will be affected in even the slightest way, it is likely that no adverse effects will result from these non-lethal actions at either the population or the species level.

But even if the full percentages given above were killed, and they were *all* treated as smolts, it would be very difficult to translate those numbers into actual effects on the species. Even if the subject was something less than one adult killed out of a population, it would be hard to resolve an adverse effect. And in this instance, that effect is even smaller because the loss of a smolt is not equivalent to the loss of an adult in terms of species survival and recovery. This is due to the fact that a great many smolts die before they can mature into adults—a good conservative estimate would be that 90 percent of outmigrating salmonid smolts do not survive to return as adults (NMFS 2002b). In fact, Bradford (1995) found salmonid smolt-to-adult survival rates to be in the range of 1 to 5 percent. Thus, conservatively, some 90 percent of the fish that may be lethally taken in the proposed research would likely be killed during the natural course of events.

Thus, taken together, some negative impact on individual fish may occur. However, permit terms and conditions, and program operational practices included in the permit application would minimize the impacts resulting in impacts that are so small that they would have an entirely negligible adverse effect on any of the listed species. As such they are not would not appreciably reduce the likelihood of both the survival and recovery of the listed species in the wild by reducing the reproduction, numbers, or distribution of that species.

5 CONCLUSION

After reviewing the current status of UCR spring Chinook salmon and UCR steelhead, the environmental baselines for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that issuance of permit 1592, as proposed, is not likely to jeopardize the continued existence of endangered UCR spring Chinook salmon, or threatened UCR steelhead nor destroy nor adversely modify any critical habitat.

5.1 Coordination with the National Ocean Service

None of the activities contemplated in this Opinion will be conducted in or near a National Marine Sanctuary. Therefore, these activities will not have an adverse effect on any National Marine Sanctuary.

6 INCIDENTAL TAKE STATEMENT

Section 9 and rules promulgated under subsection 4(d) of the ESA prohibit the take (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of listed species without a specific permit or exemption. Harm is defined as "an act that may include significant habitat modification or degradation where it actually kills or injures fish by impairing breeding, spawning, rearing, migration, feeding or sheltering." Harass is defined as

" actions that create the likelihood of injuring listed species to such an extent as to significantly alter normal behavior patterns which include, but are not limited to, breeding, feeding, or sheltering. Incidental take is take of listed species that results from, but is not the purpose of, the Federal agency or the applicant carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement (ITS) [50 CFR §402.14(I)(3)]. An ITS specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary to minimize the effect of incidental take and sets forth terms and conditions with which the action agency must comply in order to implement the reasonable and prudent measures.

6.1 Amount or Extent of Take

The measures described in this section are non-discretionary and must be included in the ITS issued by NMFS. NMFS' proposed action of issuing a section 10(a)(1)(A) permit is designed to minimize incidental take of listed species. The proposed UCR spring Chinook salmon artificial propagation program may result in incidental take of UCR steelhead because juvenile UCR steelhead are known to occur in the action area at very low numbers. Adult UCR steelhead are not expected to be impacted during any of the activities associated with the proposed programs because they are generally not in the action area at the same time as adult spring Chinook salmon, nor are they present during the spring months when juvenile spring Chinook salmon would be released.

No incidental takes of ESA-listed species are expected to occur as a result of within-hatchery monitoring and evaluation associated with the proposed programs. Incidental takes of listed species associated with monitoring and evaluation outside of the hatchery environment may occur depending on the monitoring activity. Visual Observation techniques employed in the natural environment such as redd counts and snorkeling do not involve collection or physical contact with UCR steelhead or other species. These activities may result in temporary displacement of juvenile UCR steelhead from local habitats for brief periods of time. Monitoring of juvenile spring Chinook salmon released or that are progeny of hatchery origin spring Chinook salmon that spawned in the natural environment using techniques such as juvenile fish traps may result in the capture, handling, and release of juvenile UCR steelhead. Juvenile fish trapping activities could result in the capture, handling, and release of up to 20 percent of the steelhead outmigrants from the White River and the mortality of 2 percent. However, based on the low redd count numbers, few juveniles steelhead are expected to be rearing in the White River. Additionally, it is expected that such monitoring activities would be conducted to minimize potential adverse impacts on UCR steelhead and likely include steelhead monitoring as a study objective.

6.2 Effects of the Take

In the accompanying biological opinion, NMFS determined that the level of anticipated take described above is not likely to result in jeopardy to the listed species.

6.3 Reasonable and Prudent Measures

Reasonable and Prudent Measures (RPMs) are non-discretionary measures to minimize take that may or may not already be part of the description of the proposed action. They must be implemented as binding conditions for the exemption in section 7(o)(2) to apply. NMFS has the continuing duty to regulate the activities covered by this ITS. If NMFS fails to require the applicants to adhere to the terms and conditions of this ITS through enforceable terms that are added to the permits or grant documents, or fails to retain the oversight to ensure compliance with these terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Grant PUD, the WDFW, and the YN must report the progress of their actions and the respective impacts on the species to NMFS as specified in this ITS. NMFS believes that activities carried out in a manner consistent with these reasonable and prudent measures, except those otherwise identified, will not necessitate further site-specific consultation. Activities which do not comply with all relevant reasonable and prudent measures will require further consultation.

In order to issue the multi-year section 10(a)(1)(A) permits for the proposed actions, NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize the incidental take of ESA-listed species associated with the UCR spring Chinook salmon propagation program and the monitoring and evaluation efforts:

1. The applicants should minimize the incidental take of ESA-listed species associated with the artificial propagation programs by using observational techniques whenever possible to meet monitoring and evaluation objectives.

2. The applicants should have as a long-term management target no more than 20 percent of the spawners being of hatchery origin in the White River basin.

6.4 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the program operating entities must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are not discretionary and are valid for the duration of the respective permits:

1. The Grant PUD, the WDFW, and the YN shall monitor the incidental take of ESA-listed species, including threatened, naturally produced, UCR steelhead, as a result of juvenile fish releases from the artificial propagation program. As part of the monitoring effort, the program operating entities shall attempt to determine the extent to which artificially propagated juvenile

spring Chinook salmon released from the program interact positively or negatively with the UCR steelhead's natural production in the region.

2. Annual reports shall be provided to the Salmon Recovery Division, NMFS, documenting the incidental take of ESA-listed species associated with the endangered UCR spring Chinook salmon supplementation program by January 31st of each year the permit is in effect.

7 REINITIATION OF CONSULTATION

This concludes formal consultation of the actions outlined in the applications for section 10(a)(1)(A) permits. As provided in 50 CFR §402.16, reinitiation of formal consultation is required if: (1) the amount or extent of the specified annual take is exceeded or is expected to be exceeded; (2) new information reveals effects of the actions that may affect the listed species in a way not previously considered; (3) a specific action is modified in a way that causes an effect on the listed species that was not previously considered; or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, the operation that resulted in exceeding take must cease, and consultation must be reinitiated.

8 MAGNUSON-STEVENS ACT ESSENTIAL FISH HABITAT CONSULTATION

8.1 Background

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a Federal fisheries management plan. Pursuant to the MSA:

- Federal agencies must consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (§305(b)(2));
- NMFS must provide conservation recommendations for any Federal or State action that would adversely affect EFH (§305(b)(4)(A));
- Federal agencies must provide a detailed response in writing to NMFS within 30 days after receiving EFH conservation recommendations. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with NMFS EFH conservation recommendations, the Federal agency must explain its reasons for not following the recommendations (§305(b)(4)(B)).

Essential Fish Habitat means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH:

Waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR §600.10). Adverse effect means any impact which reduces quality and/or quantity of EFH, and may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR §600.810).

Consultation with NMFS is required regarding any Federal agency action that may adversely affect EFH, including actions that occur outside EFH, such as certain upstream and upslope activities.

The objectives of this EFH consultation are to determine whether the proposed action would adversely affect designated EFH and to recommend conservation measures to avoid, minimize, or otherwise offset potential adverse effects to EFH.

8.2 Identification of Essential Fish Habitat

Pursuant to the MSA, the Pacific Fisheries Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: Chinook; and Coho (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 1999). Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC 1999), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Detailed descriptions and identifications of EFH for salmon are found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of potential adverse effects to these species' EFH from the proposed action is based, in part, on this information.

8.3 Proposed Action and Action Area

For this EFH consultation, the proposed actions and action area are as described in this Opinion above. The actions are the issuance of scientific research/enhancement permits pursuant to section 10(a)(1)(A) of the ESA for the implementation of an artificial propagation program rearing ESA-listed UCR spring Chinook salmon. The action area is within the upper Columbia River basin and includes areas in Chelan County, Washington. Specifically, the action area includes the White River and Lake Wenatchee. Additionally, the action area includes hatchery facilities operated by the USFWS on the Little White Salmon River, a tributary to the lower Columbia River, Eastbank Hatchery operated by WDFW on the UCR, and a privately owned hatchery facility in Rochester, Washington. The proposed actions may also affect EFH in the lower Columbia River and near ocean areas; however, NMFS does not believe it is possible to meaningfully measure, detect or evaluate the effects of those actions in these areas, and, consequently, NMFS will not include EFH subject to these effects in the action area. Assessment of the impacts on these species' EFH from the above proposed action is based on this information.

8.4 Effects of the Proposed Action

As described in detail above of this Opinion, the proposed action may result in adverse effects to EFH. These adverse effects are:

- Water quality impacts from water withdrawal and hatchery effluent.
- Predation of natural juvenile salmonids by artificially propagated fish.
- Competition for resources between artificially propagated and natural salmonids.
- Exchange of disease pathogens between artificially propagated and natural salmonids.

8.5 Conclusion

NMFS concludes that the proposed action would adversely affect designated EFH for Chinook salmon.

8.6 EFH Conservation Recommendation

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH. NMFS understands that the conservation measures described in the Permit Application and this Opinion are applicable to designated salmon EFH and address the adverse effects. Therefore, NMFS recommends that those same Conservation Measures and Terms and Conditions be adopted as the EFH Conservation Recommendations for this consultation.

8.7 Statutory Response Requirement

Pursuant to the MSA (§305(b)(4)(B)) and 50 CFR §600.920(j), Federal agencies are required to provide a detailed written response to NMFS' EFH conservation recommendations within 30 days of receipt of these recommendations. The response must include a description of measures proposed to avoid, mitigate, or offset the adverse impacts of the activity on EFH. In the case of a response that is inconsistent with the EFH conservation recommendations, the response must explain the reasons for not following the recommendations, including the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

8.8 Consultation Renewal

NMFS must reinitiate EFH consultation if the proposed actions are substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH conservation recommendations (50 CFR §600.920(k)).

9 DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554—the Data Quality Act (DQA)) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Biological Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Biological Opinion has undergone pre-dissemination review.

9.1 Utility

This ESA section 7 consultation on the issuance of the ESA section 10(a)(1)(A) research permits concluded that the actions will not jeopardize the continued existence of any species. Therefore, the funding/action agencies may carry out the research actions and NMFS may permit them. Pursuant to the MSA, NMFS determined that conservation recommendations included in the above Opinion were sufficient to conserve EFH.

The intended users of this consultation are the applicants and funding/action agencies listed on the first page. The agencies, applicants, and the American public will benefit from the consultation.

Individual copies were made available to the applicants. This consultation will be posted on the NMFS NW Region web site (www.nwr.noaa.gov). The format and naming adheres to conventional standards for style.

9.2 Integrity

This consultation was completed on a computer system managed by NOAA Fisheries in accordance with relevant information technology security policies, and standards set out in Appendix III, "Security of Automated Information Resources," Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

9.3 Objectivity:

Information Product Category: Natural Resource Plan.

Standards
This consultation and its supporting documents are clear, concise, complete, unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NOAA Fisheries ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).

Best Available Information
This consultation and its supporting documents use the best available information, as referenced in the literature cited section. The analyses in this biological opinion/EFH consultation contain more background on information sources and quality.

Referencing
All supporting materials, information, data, and analyses are properly referenced. They follow standard scientific referencing style.

Review Process
This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with Northwest Region ESA quality control and assurance processes.

10 References

10.1 Federal Register Notices

56 FR 58612. March 24, 1999. Final rule: endangered and threatened species: threatened status for three Chinook salmon evolutionarily significant units (species) in Washington and Oregon, and endangered status for one Chinook salmon species in Washington. . Federal Register 64(56): 14308-14328.

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67 FR 58021. September 13, 2002. Notice of issuance of enhancement permits 1196 and 1300. Federal Register 67(178): 58021-58022.

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70 FR 52630. September 2, 2005. Designation of critical habitat for 12 evolutionarily significant units of west coast salmon and steelhead in Washington, Oregon, and Idaho. Federal Register 70(170): 52630-52678.

71 FR 834. January 5, 2006. Final listing determinations for 10 distinct population segments of west coast steelhead. Federal Register 71 (3): 834-862.

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